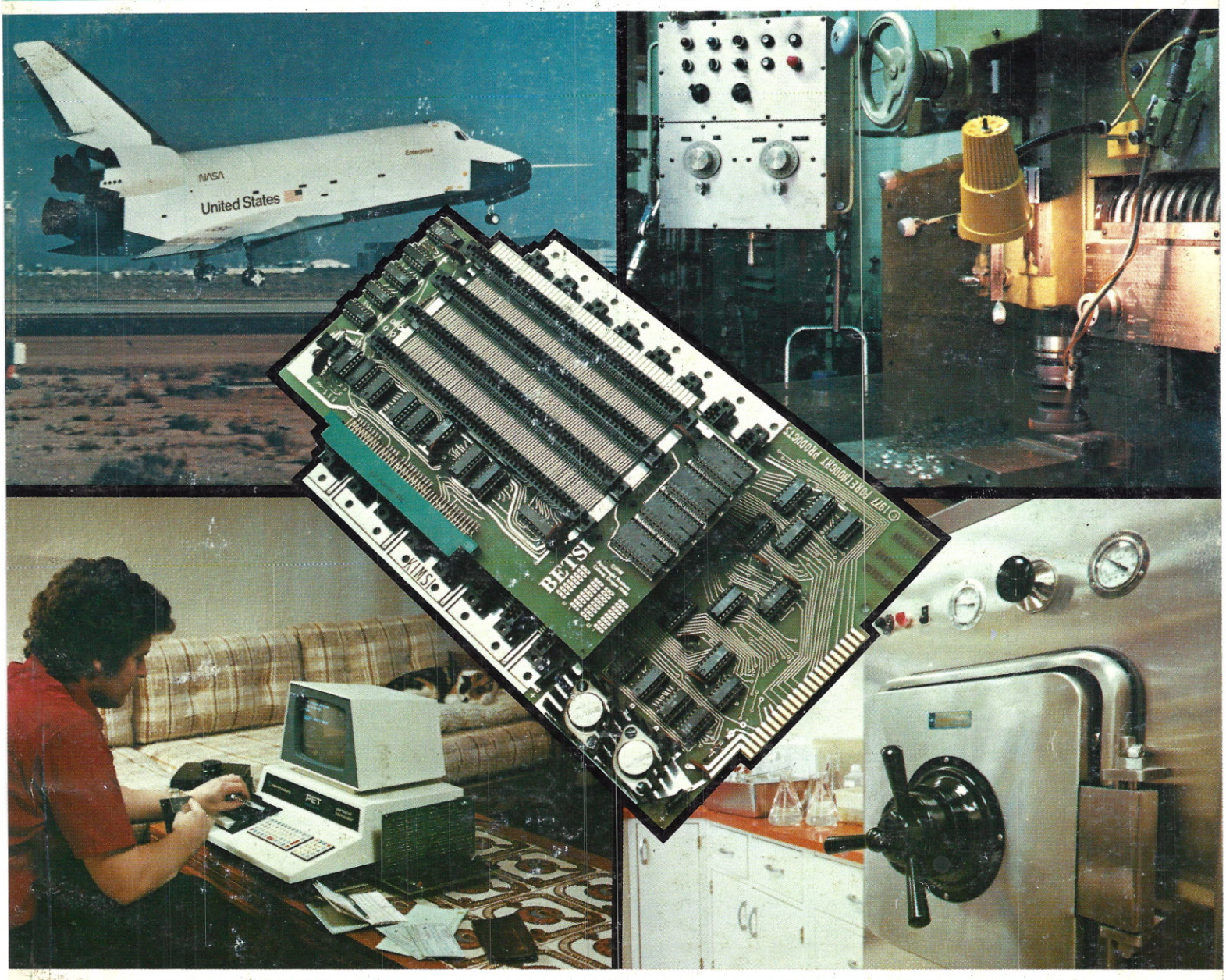
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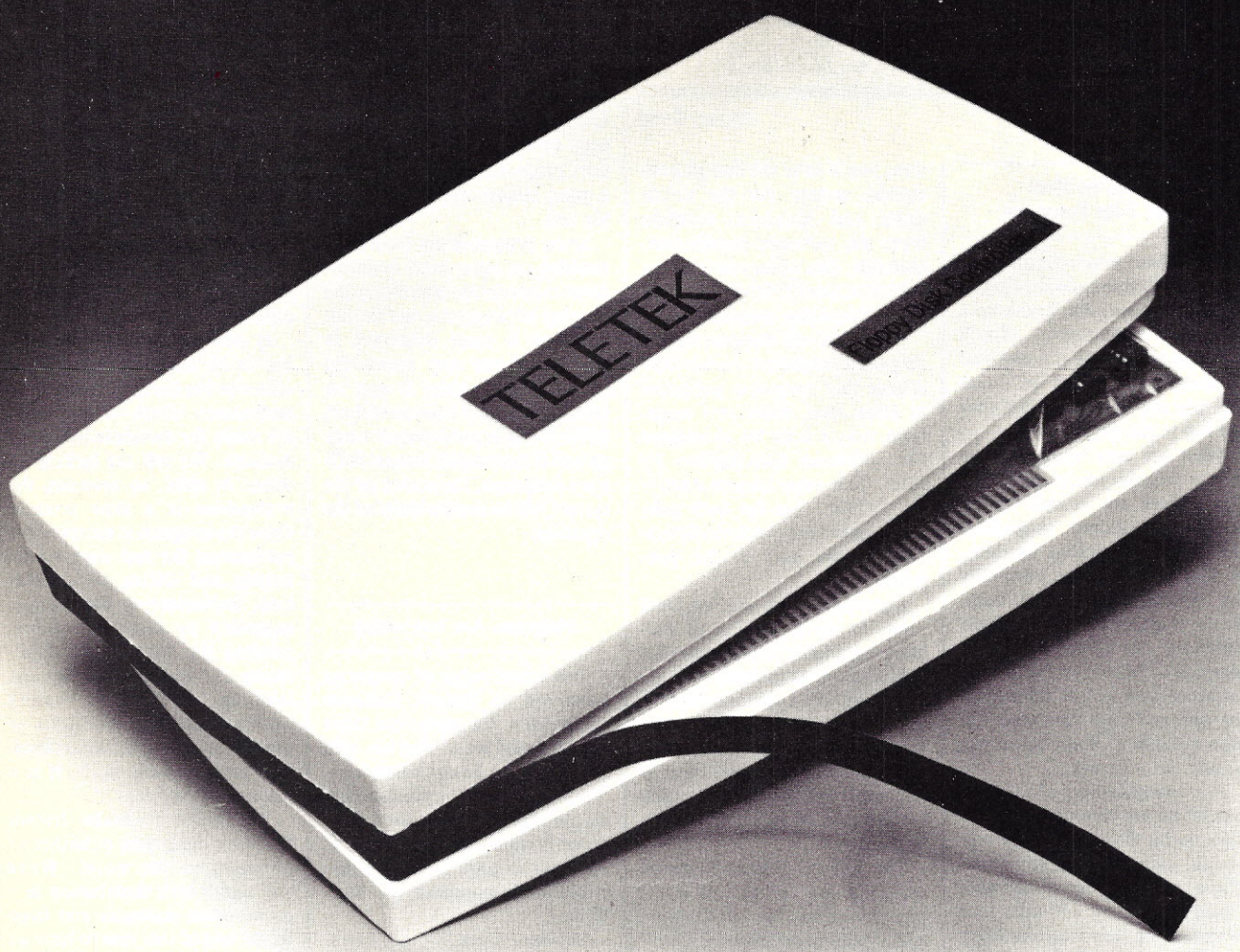
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PUBLISHER'S REMARKS

Wayne Green

Getting the Most out of Your Programs

If you have taken the time and work required to produce a good, usable program, don't pass up a chance to make money. You'll find that in the long run you tend to spend more effort on things that pay off—particularly if they are fun in the bargain.

What are your options if you have a program you've perfected? First, there are several microcomputer-oriented magazines that publish programs. Obviously, they present a good possibility for shaking the money bush. Some magazines are relatively generous; some even pay for material accepted for publication on acceptance rather than making you wait until your stuff has been published. Some make you whistle for your pay.

A growing number of software publishers are coming out of the woodwork. Some are quite reputable; some will steal you blind. There are even some software "exchanges" that will take your program and turn around and try to sell it to a publisher as original material.

When you sell your program to a magazine or book publisher you are getting a one-time payment and that's all. Let's say the magazine pays for material at the rate of $25 per printed page . . . not an unusual rate in this field, unfortunately. Thus, for a three-page article on your program, complete with the listing, you'd get about $75. *Kilobaud MICROCOMPUTING* pays up to double that rate for articles, but that still would only run to around $150 tops, perhaps $2 per hour or less for your work.

With a program publisher, you stand a better chance of hitting the jackpot. Like book publishers, the amount of money you'll make from your program will depend a good deal on the marketing prowess of the publisher and the amount of advertising the publisher will put into selling your program.

If you can sell your program as both an article and a publishable program for software distribution, you'll have the best of both worlds: money for the article rights and long-term royalties from the software distribution. Basically, this limits you to either *MICROCOMPUTING* or *Creative Computing* magazines.

Due to an odd coolness among magazine publishers there is little chance that programs published in other than those two magazines would even be considered for software distribution by them. This reluctance to distribute software that has been published elsewhere is not vindictiveness on the part of the publishers.

Currently, there are few legal rules for the protection of program copyrights. This means that publishers must proceed with extreme caution. Legal suits benefit the lawyers involved more than anyone else. They hurt both publisher and programmer, so it is important to do everything possible to avoid costly and avoidable litigation.

The folks at Instant Software recognize the softness of copyright protection for software and are putting aside some of the income being received from program sales in order to help the field develop a body of law protecting the programmer and publisher. However, keeping the prices of programs as low as possible should result in few problems arising from deliberate pirating of programs.

This is probably a good time to call to public attention the warning in each of the Instant Software instruction booklets. This explains the $10,000 reward being offered by Instant Software, Inc., for the conviction of anyone copying one of the programs. This means that if a dealer, a friend or even an enemy makes a copy of one of the Instant Software programs for you, you have a good chance of collecting the big one.

Some programmers have been working on other more sophisticated methods for preventing the copying of programs, and Instant Software is most interested in hearing about any successful schemes. Why make it easy to steal a program if you can make it difficult? If a good system turns up and is used on all Instant Software programs, the author of the system will be dealt a share of the royalties.

Programs Are Improving

The initial surge of programs submitted to Instant Software contained a few gems, but there was an awful lot of chaff in with the wheat . . . to mix metaphors. We're finding that a much higher percentage of really good programs is submitted now. Some of them are so good that the delays publication mandates are frustrating.

Between financial considerations of growth and the time required to find good people and train them, we are quite fortunate to have already met our first goal of releasing one new program package per working day. The goal of five per day set for the end of this year is going to strain both the finances and the sources of enthusiastic people. There is, I believe, a first-rate investment opportunity here for people with a bit of cash who want to make it grow. Contact Sherry Smythe for details on this.

The present sales of Instant Software are supporting a staff of 20 people. Five times more production will call for about 100 people, so there will be a lot of employment opportunities. This means that it is taking a lot longer than we like to process submitted programs and ready them for publication. The delays are on a par with those of magazine publishing.

A newly submitted program has to be acknowledged. When someone has the time, it is given a preliminary check—then copies are made for associate editors to evaluate. We still are lacking an editor in chief, so assessing the evaluations is a slow process. Once the program is accepted for publication the real work starts: writing and OKing documentation, implementing the changes suggested by associate editors, printing the instructions, duplicating the cassettes, packaging, labeling, advertising, writing catalogs, sending brochures to dealers, shipping, billing, collecting, paying royalties . . . it is a massive enterprise.

We intend to make Instant Software the largest publisher of programs in the world. We're well along with distribution in a dozen other countries and hope by the end of this year to have an Instant Software section in every computer store in the world . . . as well as in every Radio Shack. How soon will computer program stores start opening?

And how soon before it will be practical for Instant Software, Inc., to go public and make stock available? Unless I miss my guess about the prospects for computer-program sales, we may be setting up a rather extensive operation. That would be exciting. But I've missed before—being too enthusiastic—so we'll see what happens.

Reader Responsibility

One of your responsibilites, as a reader of *Kilobaud MICROCOMPUTING*, is to aid and abet the increasing of circulation and advertising, both of which will bring you the same benefit: a larger and even better magazine. You can help by encouraging your friends to subscribe to *Kilobaud MICROCOMPUTING*. Remember: Subscriptions are guaranteed—money back if not delighted, so no one can lose. You can also help by tearing out one of the cards just inside the back cover and circling replies you'd like to see: catalogs, spec sheets, etc. Advertisers put a lot of trust in reader requests for information. To make it more worth your while to send in the card, a drawing will be held each month and the winner will get a lifetime subscription to *Kilobaud MICROCOMPUTING*!

The latest winner of a lifetime subscription to *Kilobaud MICROCOMPUTING* is C. Heuser of Hilton Head Island SC.

The Gold Rush of '79

Please mark this prediction carefully. I predict that before the end of 1980 we will see the first computer-program royalty payment that comes to over $1 million.

During 1979 I expect most of the simpler programs to be written and published, making it a bit more difficult to get large royalty

payments for relatively easy programs. The first programs have been heavy on games; but as word of the incredible amounts of money that can be made via program royalties gets out, I think we'll see more and more sophisticated programs for business.

Almost every type of business needs a whole package of programs. Realtors need to be able to quickly find available properties. They need to be able to make instant calculations on various financing approaches; they need contracts on hand for immediate use; they need communications with other realtors for special properties. Insurance agents need to have data on hundreds of types of policies: customer accounts, claims records . . . a multitude of forms on hand.

Car dealers need contract forms . . . a way to find specific cars at any of a hundred other dealers . . . financing variables . . . pricing . . . direct orders to the factory . . . trade-in allowances. A talk with any businessman will quickly reveal more required applications for a computer in that business. Then all that need be done is write the programs, get them working, have them published and distributed to a few thousand computer stores and wait for the royalties to pour in.

That's the good side of it—and it *is* good, for thousands of business program packages are needed. The bad side is that for every programmer who makes a killing with a program package for a type of business, a dozen or so programmers will be too late and find the ground with the claim marker on it. How many realtor program packages are needed? One good one will do it, so as with gold strikes, those who get there first and put their claim on the best diggings will be the winners. Those who wait to see how the pioneers make out will be in the back ranks, reading about the winners in magazine articles and seeing them strutting around at conventions.

OUTPUT FROM ISI

Sherry Smythe

A recent hardware modification of the TRS-80 is screwing up some of the Instant Software programs. The change in the motherboard causes an automatic RESTORE to occur after a READ command is executed. This keeps a program from continuing to read data and can result in the title page of a program printing DIPOLE ANTENNA DESIGN BY DIPOLE ANTENNA DESIGN, for instance. This is true of all revision G boards we've checked.

Fortunately, the fix for this is simple and will be incorporated in newer production cassettes. The fix is to add an instruction to the program listing: POKE 16553, 255. Or you can type this in before loading each program if you wish, and your Level II ROM BASIC will work just fine from then on.

We Feel More Secure

After several break-ins—one resulting in the loss of a North Star Horizon and a Wave Mate Jupiter—we have installed an extensive security system. Results were almost immediate. The system went off one morning at 2:30 AM, and the police from the neighboring towns helped Peterborough's police nab two burglars right in the act. We still haven't located the stolen computers, so there is a reward of $1000 for information leading to the conviction of the nurds who stole these systems. The serial numbers of the systems are #10-01319 for the North Star Horizon and #Q61D4 5911-5 for the Wave Mate Jupiter . . . both with two disks.

Going Public

Since Instant Software, Inc., shows every sign of getting into the really big time in short order, everything possible is being done to make the issuance of stock as simple as possible. Naturally we want to wait until we have a good record of growth before going public, so it will take some time. We also want to make arrangements so that those who took advantage of our investment opportunity will get special stock options. The investment helps Instant Software grow and also provides up to 15 percent interest—where can you do better than that?

It takes money to make money, particularly in the beginning. For this reason we've set up an investment opportunity for people on the Instant Software staff and seriously interested readers.

Computer Teaching

If you are planning to write programs for computer-aided instruction (CAI), please try to group your work by grade. You might indicate whether it is for beginners in grades 1-3, for "midi's" in grades 4-6, junior-high students, high-school students or college students. If you can put together a good workbook program that will help someone painlessly master a topic, you've got a winner.

Contracts

Since the first check on a program cannot be made until we have your contract signed and in our files, it is not prudent to delay returning your contracts. While you are fussing around, someone else could easily come in with a

About the Cover

This month's cover features the Kimsi and Betsi interface boards from Forethought Products surrounded by photos depicting the range of applications that these boards have been used in. The speed and flexibility of a 6502 system utilizing S-100 expansion has proven itself in (clockwise): real-time monitoring—Space Shuttle Project (photo courtesy of Rockwell Int'l), industrial machine control, laboratory automation and data analysis, personal/home computing and other special applications.

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similar program and render yours irrelevant. If you have any questions, please write directly to me and mark the envelope "PERSONAL."

The Flow

Once a program has been submitted, we send a confirmation of receipt and a contract form to assure us that your work is honestly original. Then the program is checked by a couple of our staff members . . . and that usually includes me. If it looks good (and the percentage of good programs is increasing, I'm happy to say), copies are made and sent to selected associate editors. By the time these editors have checked out the program, commented on it—and even in some cases made substantial improvements in it—we're at least two months down the line. The pony-express mail service was discontinued quite a long time ago and the mail has been slower and slower ever since.

Rechecking the program with the author, writing the documentation and getting author approval on that all add more time. Then come the typesetting, layouts, printing the booklets, designing the package, printing the boxes, adding the cassette labels . . . it seems endless. It isn't until this time that ads for magazines can be laid out, set in type and produced . . . and then it takes a couple more months for the magazines to come out.

These built-in delays in the process add up to around five or six months before a program package can really be expected to become published and marketed . . . and that is only when everything goes OK. So don't get frustrated if things take longer than you think they should . . . we're used to it because that's the way all publishing goes. If we can think of any ways to speed things up, we'll do it . . . as long as it does not lower program quality.

PET-POURRI

Len Lindsay

Notice

Have you ever been tempted to make a copy for your friend of that neat program you just bought for $14.95? Aside from the illegality of giving away copies of copyrighted programs, there are also serious long-range side effects. After spending weeks writing, debugging and perfecting his program, John Doe will be disappointed if only a few copies can be sold because users are passing around free copies. Then he finds out that someone else is selling *his* program. That takes the cake. He just wrote his last commercially available program. If this happens too often all the good programmers will quit producing those neat and useful programs. Then all PET users will suffer. So, if you really like a program, support the person who spent the time to create it—*buy* a copy.

Beautiful Music

Micro Technology Unlimited, PO Box 4596, 841 Galaxie Way, Manchester NH 03108, is coming out with PET versions of their KIM music board and visible memory. You may see other companies copying their ideas, but MTU has the original creative minds working together. I have heard their music board hooked up to a PET. The music was in four voices simultaneously and sounded as good as the record. I was fortunate to also hear a PET speak a complete intelligble sentence using the MTU system for output. The voice was realistic—not tinny or electronic sounding. The software needed to operate their music board is available from MTU also. These should be available by the end of May.

PETSAVR

Connecticut microComputer, 150 Pocono Rd., Brookfield CT 06804, has recently announced their new product PETMOD, also called PETSAVR. This unit plugs into your PET's IEEE and user ports. The PETSAVR has one user port and two IEEE edge connectors available to the user, as well as one port for use with their Dam Systems 16-channel analog input module (AIM16). With the PETSAVR left plugged in, the PET user can plug and unplug his accessories and peripherals into the PETSAVR and save the original PET edge connectors from becoming worn down. Price is $49.50.

Software Worth Mentioning

CMS, 5115 Menefee, Dallas TX 75227, recently released a beautifully done Blackjack program that allows five people to play. The program works well with good graphics.

Tycom, 68 Velma Ave., Pittsfield MA 01201, has recently released several good PET program games using graphics. My favorite is Max, a dice game with good graphics. Players alternate shaking the two dice. Each possible roll has its rank—a 21 (a 2 and a 1) is the highest—called *max*. The next highest is 66, followed by the other pairs 55, 44, 33, 22, 11. The remaining rolls are arranged in descending order (65, 64, 63 . . . 32, 31).

On your turn you shake the dice inside a cup. No one sees the roll except you. You then claim a score. If your opponent believes you, he simply shakes the dice. Or he may doubt you and look. If you were lying, you get a point. But if he looks and you have what you claimed, he gets the point. The first person to get 10 points loses.

Starfleet Orion by Automated Simulations took me by surprise. I received a review copy within days of my request. I was shocked that it came documented, not with one manual, but with two—a 32-page *Battle Manual* and a 16-page *Rule Book*. The game comes as two programs, Orion and Builder. The main program, Orion, relies on input from Builder. Builder allows you to create your own versions of the game, just as Mike Richter's Huntwriter allows different versions of his Hunt game to be created (see PET-pourri, March 1979).

Orion is not another Star Trek. Each player commands a fleet of starships. Each ship may have different specifications. You may control movement, torpedoes, missiles, shields and even tractor beams. I have played it and must warn you: This is a thinking strategy game. Be prepared to thoughtfully read the manuals.

Publications

A large—over 130 pages—*PET User Manual* is now available directly from Commodore, 901 California Ave., Palo Alto CA 94304, for $3.50 if you include a copy of your receipt or proof of purchase of your PET computer and your PET serial number. Surprisingly, delivery takes less than two weeks. Information from all previous tiny manuals is included in this larger manual—plus some new information. Here are a couple examples of new information included:

Page 31—"FRE forces a BASIC action called garbage collection. This consolidates all unused bytes into one large block so that they can be efficiently allocated."

Page 30—". . . use the RND (−TI) to seed a number sequence, and use RND(+1) for the numbers in the sequence."

Page 29—"SGN . . . returns a 1 if the sign of the number is greater than zero, a zero if the value is zero, and a −1 if the sign is negative."

Page 25—"The only characters that are allowed to appear in reverse field between quotes are those which are interpreted as control characters."

Looking for a good book on BASIC? *BASIC For Home Computers, A Self-Teaching Guide* has just been released by Wiley & Sons, 605 Third Ave., New York NY 10016. Bob Albrecht is one of the authors, so you know it must be good. I have a copy, and it *is* good. Microsoft BASIC is used throughout. PET BASIC is a special version of Microsoft BASIC. There are plenty of examples and sample program listings. Price is $5.95.

I recently received a copy of *The Strawberry Imperative* that I ordered from Innovision, PO Box 1317, Los Altos CA 94022. The price is $3.95. This 20-page typeset report comes with a bright red plastic cover. It includes some good information and charts. For example, it explains how to use several PEEKs to find the exact location of the cursor. Many PEEK/POKE locations are not discussed, and a detailed memory map to PET locations is not in-

cluded. But this report does help to give someone new to programming some good insights and examples of how to include PEEKs and POKEs in programs.

Commodore in California has finally published the first issue of their newsletter. Both Commodore in England and Canada have had PET newsletters for quite some time—and the U.S. newsletter was definitely not earth shattering. Of course it includes lists of all announced Commodore products and software for the PET (announced does *not* necessarily mean that they exist). It also includes many reprints from the English newsletter. The print on most of the program listings is so light and broken that it is virtually illegible. A 6-page list of PET dealers is also included. The price is $15 per year. Their accompanying letter states, "This cost will soon be repaid by the time-saving and cost-effective information given."

The Vancouver PET Users' Group, PO Box 35353, Stn "E," Vancouver BC, Canada V6M 4G5, is now publishing *Vancouver PET News*. Price is $1 per copy. Their first issue is 15 pages and contains program listings, tips and even cartoons.

It appears that the PET is England's number one personal computer, so it's no surprise that each issue of *Practical Computing*, 2 Duncan Terrace, London N1, England, has several articles aimed at PET users. This English magazine is well done. It is enjoyable to read the ads for PET products and software available in England. Overseas subscription is 12 pounds per year (12 issues).

Also in England is the Independent PET User Group, 9 Littleover Lane, Derby, England, which is publishing a newsletter. Further information will, I hope, be available next month.

```
10 GOTO900
100 PRINT"♥ TAPE TEST  BY  JIM BUTTERFIELD"
110 POKE59468,12
120 PRINT:X$="LEADER":GOSUB500
130 X$="DATA":GOSUB500
140 X$="ERROR":GOSUB500
150 INPUT"TAPE UNIT";T
160 IFT>2ORT<1GOTO 150
170 POKE 241,T
180 SYS(1280):END
500 PRINT"┌─┐"
510 PRINT"│  │";X$
520 PRINT"└─┘"
530 RETURN
900 Z=1280
910 READX:IFX=999THENGOTO100
920 POKEZ,X:Z=Z+1
930 GOTO910
1000 DATA 32, 59, 248, 120, 166, 241, 202, 240, 21, 206
1001 DATA 19, 232, 169, 144, 141, 78, 232, 173, 64, 232
1002 DATA 142, 8, 2, 41, 239, 141, 64, 232, 16, 11
1003 DATA 238, 17, 232, 169, 52, 141, 19, 232, 141, 7
1004 DATA 2, 169, 104, 141, 25, 2, 169, 5, 141, 26
1005 DATA 2, 88, 32, 30, 249, 44, 19, 232, 16, 248
1006 DATA 162, 2, 160, 0, 169, 32, 149, 56, 181, 48
1007 DATA 240, 6, 148, 48, 169, 160, 149, 56, 202, 16
1008 DATA 239, 165, 56, 141, 122, 128, 165, 57, 141, 242
1009 DATA 128, 165, 58, 141, 106, 129, 32, 54, 247, 16
1010 DATA 206, 48, 204, 0, 32, 116, 5, 44, 64, 232
1011 DATA 44, 16, 232, 76, 126, 230, 174, 73, 232, 173
1012 DATA 72, 232, 236, 73, 232, 208, 245, 160, 255, 140
1013 DATA 72, 232, 140, 73, 232, 224, 252, 144, 8, 224
1014 DATA 255, 208, 7, 201, 80, 144, 11, 230, 50, 96
1015 DATA 224, 254, 208, 16, 201, 96, 144, 12, 165, 232
1016 DATA 41, 252, 240, 3, 230, 48, 96, 230, 232, 96
1017 DATA 169, 0, 133, 232, 230, 49, 96, 999
```

Program A (program has been put into public domain). Machine language as converted into DATA statements doesn't work quite as well as a direct load.

Commodore News

Chuck Peddle is back with Commodore. He left Commodore a while back to work with Apple. As original designer of the PET, Chuck is a welcome return to Commodore. Commodore has had a large turnaround in personnel. Many key people have left. Some are now making PET-compatible products on their own. Bob Skyles is marketing large keyboards and memory expansion for the PET now. Greg Yob is writing his own PET user manual. The new management of Commodore is trying to give better service and support. With some tough competition from Atari and TI, the PET may not survive without good service and support.

Commodore has now announced a full line of peripherals for the PET. Remember, these are only announcements. The PET 2001-16N Computer has 16K bytes of memory and a large keyboard with numeric pad and graphics on keys. Cassette is not included in the $995 announced price.

The PET 2001-16B is the same as above, except it has a standard typewriter keyboard and no graphic keys . . . same price too. The PET 2001-32N is the same as the 16N but with 32K memory. Price is $1195. The PET 2001-32B is the same as the 16B but with 32K memory. Price is $1195.

The PET 2021 Printer is an 80-column matrix electrostatic printer with full graphics for $549. The PET 2022 Printer is an 80-column dot matrix printer using plain paper with tractor feed and full graphics for $995. The PET 2023 Printer is the same but without tractor feed for $849. The PET 2040 Dual Drive Mini Floppy Disk can store 343K and sells for $1095. It cannot be attached to the original 8K PET without modification. The PET 2041 Single Drive Floppy Disk can store 171K and sells for $595.

Tape Head Alignment

Poor tape head alignment seems to be a major problem afflicting most PET computers. Tape heads may be aligned slightly high or slightly low. If your PET's heads are slightly high you will have a difficult time reading tapes made on a PET with heads that are slightly low. You can align your heads yourself, but it is tricky business. Jim Butterfield to the rescue.

Jim has come up with a beautiful little program that will test a tape as your PET is reading it (see Program A). This program constantly tells you what your PET thinks it is reading, either LEADER or DATA, or if it finds an error. If your PET thinks it is reading DATA when your tape is LEADER you have a problem.

You can use this program to align your heads perfectly if you use a tape that is all leader (2800 cps signal written on professional equipment). Or if you receive a tape from someone else that your PET won't read, you can align your tape heads with that tape.

You need a tiny screwdriver and patience to adjust your head alignment. *PET User Notes*, Vol. 1, No. 2, explains tape head alignment on page 2. Open the lid of your tape unit. There should be a small hole about an inch above the FFWD label. It is covered up when the lid is down. Depending on what type of tape unit came with your PET, the alignment screw should be directly under this hole when your play button is depressed.

If you pry off the silver Commodore name plate on the lid, you will find a hole in the lid that lines up with the other hole you found. You should be able to turn the alignment screw now while your PET is reading a tape. Now it is just a matter of moving your tape head slightly up and down until the TAPE TEST shows LEADER first then DATA (header), then a brief LEADER followed by DATA (the program).

Your letters are always welcome. Send to: Len Lindsay, 1929 Northport Dr., Room 6, Madison WI 53704.

OHIO SCIENTIFIC

SMALL SYSTEMS JOURNAL

Welcome to the Ohio Scientific Small Systems Journal

The journal will now be a regular part of Kilobaud Magazine. Ohio Scientific's journal will feature new product announcements, detailed analysis of interesting software and in-depth discussions of the technical aspects and applications of Ohio Scientific products. The journal has been sporadically produced over the last three years as a service to Ohio Scientific computer owners. However, the company is dedicated to producing computers and software and is not a magazine publisher. Consequently, we have not been very successful in getting the journals out on time. The journal will be approximately one-half personal and one-half small business oriented. It will often contain information of general interest to users of other 6502 based equipment as well as other computer systems which utilize Microsoft BASIC.

New Color, Sound and AC Remote Control Option for C2-4P and C2-8P Products

The C2 series computer products have been enhanced regularly during their history. This is possible because of the computer system's modular construction which allows one portion of the computer system to be enhanced without obsoleting other sections. The C2 series has just been enhanced with the availability of options which provide color display capability, two types of sound output and a unique AC remote control system. These options are available on new C2-4P and C2-8P products as well as being available as upgrade kits for all existing C2-4P and 8P products in use. To obtain a prospective on what the new options do, let's first quickly dscuss the original capabilities of C2 series computer products.

The standard C2-4P is a BASIC-in-ROM or mini-disk based computer system which includes video display interface and keyboard. The video display interface is capable of displaying 32 rows of 64 columns (2048) characters. The internal character generator has 256 distinct characters including upper case, lower case, graphics generating characters and special illustrating elements such as airplanes, tanks, cars, boats, spaceships, etc. When utilizing the graphics and gaming elements, the screen has an effective resolution of 256 by 512 points. Because the screen is accessed in 64 point blocks, elaborate animation is possible even with rather slow programming techniques such as BASIC. For instance, programming an arcade style tank game is a trivial task in BASIC on the C2-4P, whereas it is a monumental, if not impossible, task on other personal computer systems. The C2 series products utilize an upper and lower case ASCII type keyboard which is treated as a scanned array by the computer system. The internal software normally configures the keyboard as a standard terminal input device, however, the user's software can directly scan the keyboard to detect simultaneous and multiple key closures. The video display is contained on one OSI 48 line BUS board (540) and the upper and lower case keyboard is a 542 board which connects to the computer via the 540 video board.

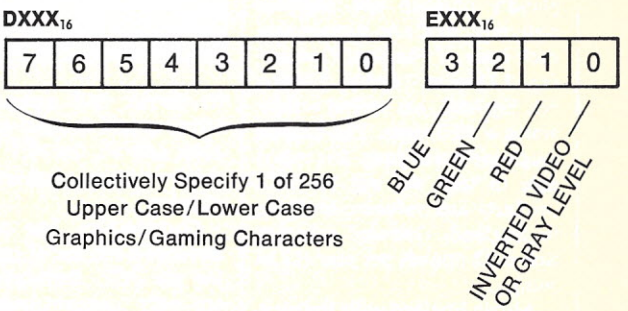
New Options

The sound, color and AC remote options upgrade the 540 video display and keyboard in conjunction with offering an external AC control system. The new video display board (540B) provides the following enhancements.

- All capabilities of the older 540 board including 32 x 64 alpha and high resolution graphics
- 16 colors including black and white
- Reverse video capability
- Home control interface compatible with the AC-12 remote control system
- Compatibility with the 542B keyboard

The 540B utilizes memory mapped video which occupies hex address D000 through D7FF with 2K by 8 memory to specify the 2048 locations which have 256 discrete character possibilities each. The color option adds 2K by 4 graphics memory from E000 to E7FF including three bits which specify color and one bit to specify inverted video. This, locations D001 and E001 collectively specify the second screen location via 12 bits as specified in the register assignment below.

Diagram 1



The video output circuitry of the 540B supports standard black and white closed circuit monitors, composite video with separate RGB gun drive and composite color video suitable for use with color television monitors or commonly available RF converters and home color television sets. However, the extremely high resolution of the 540 system (64 character wide display and 512 dot resolution) indicate the use of a high performance color television such as the Sony Trinitron series. It should also be noted that the video display memory occupies 4K of dedicated memory which does not interfere with normal program memory. Many competitive computer systems include the display memory as part of the program memory thus reducing the overall programmability of the computer system for a given memory size, however, a 4K C2-4P has 4K user programmable memory plus 4K of display memory. The 540B video display board also incorporates the circuitry for the 542B sound keyboard and the computer portion of the interface of the AC-12 remote control system.



542 Rev B Keyboard

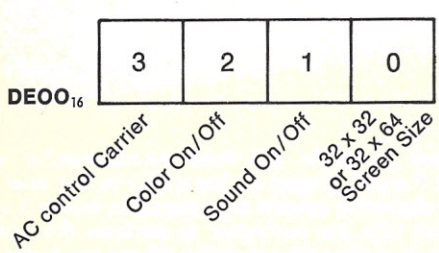
The 542 Rev B keyboard maintains all the capabilities of the older 542 keyboard plus the following features:

- Programmable audio output generator (range 200 hertz to 40 kilohertz)
- 8 bit D/A converter for voice and complex sound output
- Interface for two external keypads and two 8 axis joy sticks

Programmable Sound Output

Most personal computers with sound output have a single bit port which can produce sound only with the constant attention of the microprocessor. This means that an interactive game must stop processing animation while it is outputting sound. Ohio Scientific has solved this with a programmable divider which will constantly output a tone as specified by the contents of one memory location. Thus, a BASIC program can easily support a real time animated game with sound output because the "overhead" for sound generation is minimal. The programmable divider sound output is specified by the contents of the one memory location and can be turned on and off via another register as specified in Diagram 2.

Diagram 2 540B Control Register



D/A Converter

The keyboard also incorporates an 8 bit companding D/A converter. This is an 8 bit converter which has been optimized for voice and music output. The companding feature means that the converter's performance is roughly comparable to a 12 bit D/A converter's performance when used for voice and music. In theory, the microcomputer in conjunction with the companding DAC can generate any sound including voice, music, etc. In practice, the programming level required for such a feat is very difficult. However, it is possible to generate limited band width speech and complex musical chords with the ultra fast 6502 microprocessor. These areas will be the topic of a future systems journal article.

Joy Stick and Keypad Interfaces

The original 542 board as well as the new 542 board can be user scanned to detect multiple key closures, instantaneous key closures and normal Basic input. The keyboard has been expanded to include the ability to connect external devices such as a 10 keypad and 8 axis joy sticks. Twin joy sticks which plug into the 542 Rev B are expected to be available during the third quarter 1979.

AC Remote Control

Personal computer users have long aspired to control lamps and appliances around their home with a computer system. This has been possible for a long time via direct wiring, however, such an approach is costly, messy and sometimes dangerous for the home owner and nearly impossible for the apartment dweller. A much better approach to controlling lights and appliances is to inject a control signal on the AC power line the same way wireless intercoms do. Such systems have been marketed for the last few years but their high cost ($100 or more per remote appliance) has made them prohibitively expensive for most enthusiasts. Recently, BSR introduced the X10 home wireless control system (non-computerized). This system incorporates a command console which can control up to 16 independent channels of lights and appliances. Remotes are in the form of appliance modules which switch up to 15 amps, lamp modules which provide proportional brightening and dimming and wall switch modules. Each remote is about $15 retail bringing remote wireless control within the range of virtually all hobbyists.

Ohio Scientific is now offering the AC-12 remote control starter set including an OSI modified BSRX10 console, two lamp modules, two appliance modules and extensive software. The AC-12 system will plug in to any computer system using the 540 Rev B video board and will soon also be available for the popular Challenger IP product line. However, a computer interfaced AC remote system will be of little practical use over a manually operated remote system unless it is fully integrated into the systems design via software and additional support hardware. This has been accomplished with the AC-12 system by use of a special home control OS-65D V3.0 floppy disk operating system available now on C2-4P mini-disks and shortly for C1P mini-disk systems. This complete home control operating system includes the following capabilities:

- Compatibility with normal BASIC programs
- Supports the time of day
- Supports a count down event timer
- Supports up to 16 separate channels of AC remote control
- Includes proportional control of lighting
- Constantly maintains on/off sensor detection of up to 48 inputs
- Disk based command files
- Disk event logging by time or event
- Monitoring time and inputs possible while running other BASIC programs, i.e., "Foreground and Background" operation



540B and AC-12

AC Control Software

The control BASIC incorporates a new reserved word ACTL which utilizes the syntax ACTL device, operation where device and operation are number codes. Thus, to turn on the outside light might be programmed as 20 ACTL 14, 65. Obviously, programming home control is simple and straightforward with this syntax.

Both the C2-4P MF and C1P MF systems incorporate an internal real time clock which the home control system supports by maintaining time of day and utilizing the one second clock ticks to prompt other investigative actions. Thus, the operating system always knows what time it is and maintains a count down timer which can cause a user specified action to occur. The operating system can be programmed to do something at a specific time or a relative time such as "two hours from now." The operating system also supports Ohio Scientific's 96 line parallel I/O board (CA-12). The system can monitor up to 48 of these lines as inputs and can take action with one second resolution based on a level change. So by using the CA-12 input to monitor switches on doors and windows and other sensors, a computer system can be constantly aware of activity in and around the home. Finally and most importantly, the home control operating system can operate in "Foreground and Background mode." That is, it can run normal BASIC programs while simultaneously maintaining time and monitoring inputs. So in the system's ultimate configuration, you could be sitting in the den playing an exciting video game and be immediately notified as an intruder opened a window in another portion of the home. The computer system can also take prescribed action such as turning on appropriate lights, sounding an alarm and logging the intrusion event on disk.

The AC-12 remote system can be simply used to turn a few things on and off or it can be expanded to a full blown computerized home control system.

The following is the pertinent price information for current color, sound and AC remote options and upgrade kits:

Color and Sound Option on C2-4P and C2-8P	Add	200
CA-11B 540 B color video board for system upgrades (does not include 542B sound keyboard)		225
CA-11C 540B color video board and 542B sound keyboard		299
AC-12 Remote AC control system, including console, four remotes and software		175

Purchase from your local OSI dealer.

Ohio Scientific Winchester Disk Interface Technical Information

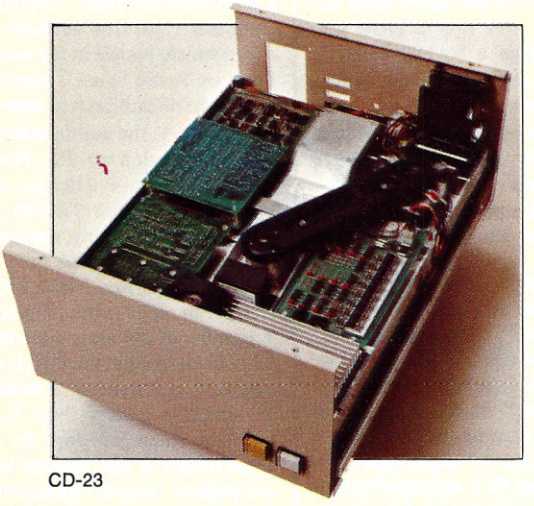
Ohio Scientific has developed a universal three board Winchester disk interface for use with its 48 line BUS system and virtually all available 14″ and 8″ Winchester Technology disk drives. The system is based on three circuit boards, the Model 525 dual port RAM board, Model 590 disk controller and Model 592 disk interface (which must be placed close to the internal electronics of the hard disk drive). The key to the performance of the Winchester Disk interface is the dual port memory board. Basically, a dual port memory board allows two separate data busses to access its memory. This dual port memory board is used as the disk buffer for read and write operations and is typically configured for 3580 bytes per transfer.



C3-B

In normal operation the host microcomputer writes the information it wants placed on the disk into the dual port RAM buffer. The operating system then specifies where it wants it on the disk and tells the controller to perform the transfer. The controller then performs the transfer without any further intervention of the host microcomputer system. It then flags the host when it is done. For read operations, the operating system tells the controller what sector it desires, then the disk controller brings that sector from disk to the buffer. The operating system then utilizes the information in the buffer accordingly.

The most important feature of this configuration is that no interrupts or DMA transfers are required for normal disk operation and so the system is totally interruptable during all phases of disk operation. This means that the host microprocessor is available 100% of the time for servicing communication interrupts in conjunction with the hard disk. This feature allows a relatively small microcomputer to perform effectively under high work load timeshare and distributed processing conditions.



CD-23

CD-23 Hard Disk

Low end small business computers typically use mini-floppies or 8″ floppies for data file storage. Floppy disks range typically in storage from 80 kilobytes to about 600 kilobytes per surface. This is not enough storage for the important accounting and information files for any but the smallest companies. Consequently, most businesses resort to using multiple floppy diskettes, specializing the files on each diskette so, for instance, one diskette contains accounts receivable, another diskette contains accounts payable, etc. The computer operator is typically required to remove and install floppy diskettes during the normal course of computer operations. Floppy diskettes are also fairly slow due to their 300 to 360 rpm rotational speed. Consequently, for many types of computer operation the mechanical movement of the floppy disk is the most time consuming operation.

Until recently the only alternative to floppy disks for mass storage was removable cartridge hard disk drives. These drives are typically very expensive and very delicate because even the smallest microscopic particle will contaminate the system and cause failure of disk heads and media.

A third new alternative was introduced in the mid-70's principally by IBM, the Winchester Technology disk drive. These disks are large hard disks which have non-removable media. They have sufficient capacity so that it's not necessary to exchange disks during a normal operation. The disk surfaces and disk heads are permanently sealed in a contaminate free chamber. Modern Winchester disk drives have large capacities ranging from 10 to 300 megabytes and operate at 3000 rpm giving comparable access speeds to the very fastest disk drives available and are the simplest media to operate. A Winchester disk usually has an on/off switch and no other user accessible controls. Thus the Winchester Technology disk drive is the ideal mass storage device for modern small business computers. One drive can easily store all the information pertinent to a company's operation. It has fast access speed, a very long operating life and is virtually operator proof since it simply has an on/off switch.

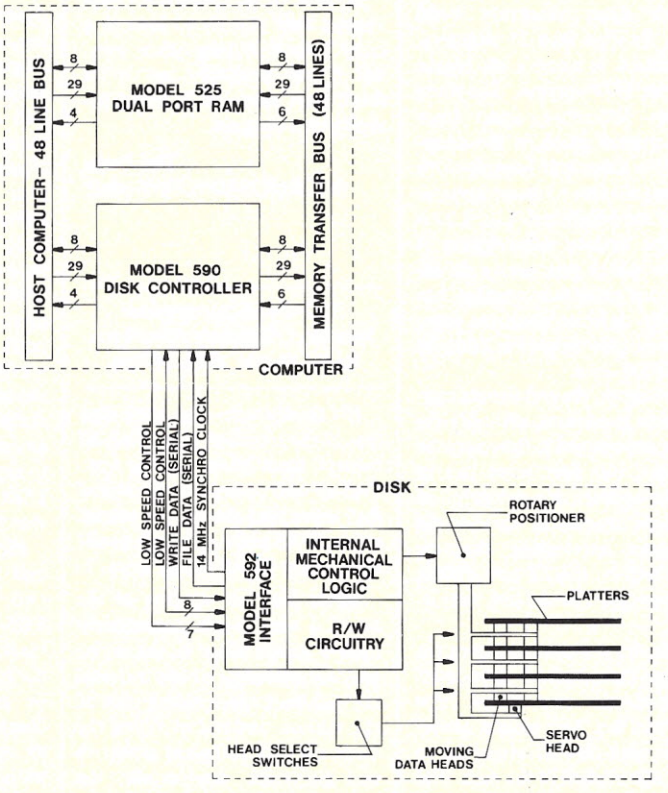
In mid-1977 Ohio Scientific introduced the first Winchester based microcomputer system, the C3-B computer with disk and the CD-74 add-on disk for existing Ohio Scientific products. The CD-74 is a 74 million byte Winchester disk and has been in production and use nearly two years with excellent reliability and service. The only problem with the disk drive is that the demand for the Winchester based microcomputer has far exceeded the supply of disk drives due to production capability limitations at the disk vendor.

Recently, Shugart (one of the world's largest manufacturers of floppy disk drives) released a series of smaller capacity Winchester disk drives, the SA4000 series. Since Ohio Scientific has far more expertise and experience with Winchesters than any other micro manufacturer, we quickly incorporated the Shugart SA-4008 into our product line, producing the new CD-23 23 megabyte Winchester disk and a corresponding full computer system, the C3-C. The CD-23 system offers the same great features as the CD-74 systems including compatibility with OS-65U single user, timeshare and distributed processing configurations as well as the fast access time, inherent reliability and simplicity of Winchester Technology. The CD-23 and C3-C systems have been in production since January, 1979 and have helped to alleviate the backlog situation on CD-74 disks so that now both types of Winchester products are available from Ohio Scientific with reasonable delivery schedules.

Table I lists Ohio Scientific Winchester Technology Disk products.

Table I

C3-B	16 slot Challenger 3 with 48K static RAM, dual floppies and CD-74 hard disk in a 48″ high equipment rack complete with OS-65U Level 1 operating system	$11,900
C3-C	Same as above with CD-23 hard disk instead of CD-74	9,340
CD-74	74 million byte Winchester disk, interface, OS-65U software and bootstrap ROM for expansion of any Challenger III product	6,800
CD-23	23 million byte Winchester disk, interface, OS-65U software and bootstrap ROM for expansion of any Challenger III product	4,250



BOOKS

An Introduction to Microcomputers, Volume 2—Some Real Microprocessors
Osborne and Associates, Inc.
Berkeley CA
Ringbound, $30, 1978
1979 updates (6), $25

This is actually the third volume of the Osborne and Associates' *Introduction to Microcomputers* series; volume 0 is for the absolute beginner, and volume 1 is for the novice. The use of "Introduction" in the title is misleading, as this volume (and its companion volume 3) is an independent survey of nearly every microprocessor on the market. If you are intrepid enough to read it from front to back, you may well feel that you've been married to the devices rather than just introduced!

With approximately 1400 pages, divided into 23 chapters, this edition is quite a bit bigger than the 1977 version. The most obvious difference, apart from the increased price, is the adoption of a loose-leaf format—this is to enable you to insert updates as they are published. Catch 22 is that the update subscription is $25, for which you receive six updates (one every two months), but the only definite chapters mentioned as updates are the Zilog Z8 and Z8000 ones.

Obviously, the publishers cannot know in advance what devices will be announced in the course of the year, but they want you to buy the updates as a subscription . . . sight unseen. In my view the two most interesting chapters could well be the Z8 and Z8000, but they could be the last ones issued!

If you have ever read any of the previous Osborne and Associates' publications, you know how good they are. This edition carries on the tradition of attention to detail established in the past. The majority of the chapters are the same as the 1977 version; however, seven of the chapters are either new or expanded.

As the table of contents runs to 11 pages, and the index to 12 pages, it is not practicable to give a complete breakdown in a review of reasonable length. Suffice it to say that if you want information on virtually any current microprocessor device, it is in this book. With each microprocessor is a detailed description of all its specific support devices; volume 3 has the details on general-purpose support devices.

Overall the book is excellent, but if you have a previous edition or want information only about one specific device, it is quite expensive (with the updates, up to $55). Two ways to economize are to order it without a binder (saves $5) and get volume 3 updates as well (only $40 for both sets)—but Catch 22 makes you get volume 3 as well—total cost without binders, with updates, is $80 (plus postage).

Because of the expense I would suggest that you try to look at a copy before buying your own, but it will probably cost a lot more next year—so it could actually be a bargain.

Jim Perry
***MICROCOMPUTING* staff**

TRS-80 Microcomputer Technical Reference Handbook
Radio Shack, 1978, 107 pp.

It's finally here—the book that tens of thousands of rabid TRS-80 owners have been waiting for: *TRS-80 Microcomputer Technical Reference Handbook*. It's priced at just $9.95 and is generally available at any Radio Shack store.

After just one reading of the book, I was struck immediately by two things about it: the depth and completeness of the text and the laid-back easy-reading style of the author. Instead of filling the book up with technical gibberish and electronic double-talk, the author put everything into plain, everyday English, with a little humor thrown in to keep things interesting.

Please be advised, though, that this book is not for the novice. As the author states: "This book was written for the technical person, by a technical person. It was not written to educate the average owner of a TRS-80 microcomputer. If you do not know what hex means . . . or how a NOR gate differs from a NAND gate . . . you are not prepared to repair your computer." Before a novice reads this book, I suggest he read Osborne's *An Introduction to Microcomputers, Vol. 0* and *Vol. 1*, Don Lancaster's *TTL Cookbook* and back issues of *Kilobaud*.

The *Handbook* is divided into three main sections: "Theory of Operation," "Troubleshooting" and "Outside World Interfacing." The first part, "Theory of Operation," is the biggest and most interesting section in the book. In it, the entire operation of the TRS-80 is explained in rich detail. Some of the subjects covered are address and data line operation and decoding, RAM operation, video and keyboard sections' use of memory mapping to work and the inner workings of the power supply. Also included is a system block diagram, a memory map and a whole section in the back of the book devoted to schematics, including changes made in the various production models.

The second section, "Troubleshooting," is basically a guide for keeping your TRS-80 in tip-top shape. Included here are such subjects as power-supply checks and adjustments; RAM; ROM; cassette, video and keyboard troubleshooting; a section-isolation flowchart for pinning a problem down to a specific section; and a list of the most common problems encountered in the TRS-80 and their specific remedies. I found this section of the book valuable because reading it was like taking a course in troubleshooting. Most of the procedures outlined here could be applied to any microcomputer and, in fact, to any piece of digital equipment. I felt that this chapter alone was worth the price of the book.

Finally, the last part, "TRS-80 and the Outside World," gives two methods of using your TRS-80 to control real-world devices. However, the author does not merely tell you how it is done; he actually shows you using a computer-controlled coffee pot as an example. The two techniques used are memory mapping and port control.

All in all, I found the *Technical Handbook* a worthwhile and enlightening book. The only criticism I can offer is that this book should have been included with the TRS-80 in the first place, instead of being an option. However, since the TRS-80 was never really intended to be a hobbyist machine, but rather was meant as a mass-merchandised "appliance computer" for the millions of nontechnical people in the world, I can see Radio Shack's point.

A word of caution is in order at this point. As the author states in the introduction to the *Handbook*, any attempt to tamper with the innards of your TRS-80 will immediately void any warranty. Even worse, it will also raise the price of authorized Radio Shack service. In other words, if it costs X number of dollars to have your TRS-80 serviced at a dealer, it will cost you some number of dollars, Y, which is greater than X, to have the same job done by the same dealer if the factory seals are broken. Sounds like hobbyist discrimination to me.

If you have trouble finding the *Handbook*, you can ask your nearest Radio Shack dealer to order a copy for you, though it might take several weeks. But, even if it does, the wait will be worth it.

David Sticha
Chicago IL

Accounts Payable and Accounts Receivable
Lon Poole, Mary Borchers
Osborne and Associates, Inc.
Berkeley CA, $15

If you have in mind writing an accounts-payable and accounts-receivable business package, then studying this book is the best way to start. This is the second book in a series of commercial applications published by Osborne and Associates.

The book starts with a brief overview of the A/P and A/R systems as designed and used by O & A on the Wang 2200 minicomputer; then it moves into chapter 2, which is devoted to the data files.

Different file-accessing methods are briefly discussed here and then followed by a file-description table with the file names, file descriptions and access methods used. Subsequently, each file is presented in even more detail with information such as blocking factor, record size, key location, length and location of each field. In the actual files, all the data are stored as strings. Numeric values are converted into the strings in binary coded decimal (BCD) format in order to pack more data on the disk.

Chapter 3 covers a general overview of accounts-payable and accounts-receivable processing. It describes how the programs work and suggests how and when to run them. Also, the exceptional procedures are mentioned here.

Chapter 4 is the actual user's manual and contains step-by-step instructions for use of all programs. Detailed explanations of how the programs work are accompanied by user flowcharts. These flowcharts illustrate actions taken by the operator and the computer from the user's point of view. All screen layouts are shown, and each field on the screen is described. In the case of a report program, a sample report is shown. Error recovery and exceptional procedures such as year-end runs are explained, too.

Chapter 5 goes into the special hardware and software features of the Wang 2200B minicomputer system with 16K RAM. Most of the Wang features and extensions are discussed and accompanied with examples, and an attempt is made to provide the reader with conversion guidelines for other BASIC versions. Unfortunately, nowhere in this book can you find an indication of what disk configuration was used and how much disk space is needed for all files in a typical installation.

Customization of the A/P and A/R systems is the theme of chapter 6. Various aspects of the custom-tailored system are explored, with suggestions on how to change the passwords, report formats, screen layouts, data files; how to convert keyed access files to relative access files; how to add the invoicing program and much more.

Chapter 7 is concerned with initialization of the files and programs. It guides the prospective user or programmer through the implementation task with detailed descriptions of how to reserve disk space, create files, set up the screen masks and initialize the totals and counters.

Chapter 8 contains complete program listings for all 21 programs discussed in the previous chapters. The program listings contain cross-references to called subroutines and all variables used, which is extremely helpful for "walking through" the programs. Although there are very few remarks in the actual program code, good remarks are included in the margin next to the listing for each program.

This review is strictly a review of the book and not an attempt to evaluate the published programs. As such, this book is an excellent opportunity for somebody with a Wang computer to make his A/P and A/R programs operational. The overall organization of the book is good, and it can serve as a model for a user's manual. The manual will help tremendously in setting up the business system and making it through the initial "learning" stage. However, the small businessman or inexperienced programmer contemplating conversion of this package for other computers should be aware of possible problems in the conversion because too many Wang BASIC extensions are used. Also, the capacity of the system and transaction volume should be investigated before the conversion is started.

Les Palenik
Scarborough Ontario
Canada

STAND ALONE

VIDEO TERMINAL

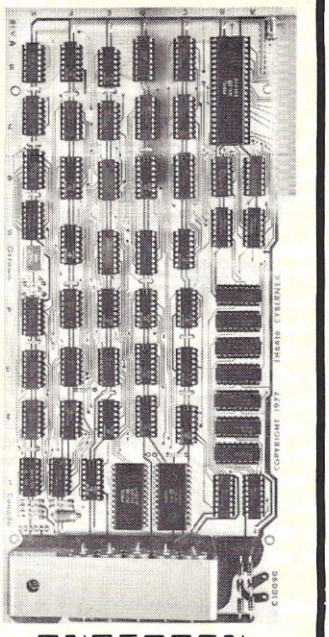
Now, a completely self-contained video terminal card for less than $150.00. Requires only an ASCII Keyboard and TV set to become a complete interactive terminal for connection to your computers serial IO port. Two units available, common features are: single 5V supply, crystal controlled sync and baud rates (to 9600 baud), computer and keyboard operated cursor control, parity error and control, power on initialization, forward spaces, line feed, rev. line feeds, home, return cursor, and clear to end of line. Power requirements are 5V at 900ma, output std. IV p-p video and serial TTL level data.

Features:	TH3216	TH6416
Display	32 characters by 16 lines 2 pages	64 characters by 16 lines scrolling
Characters	Upper case ASCII	Upper/lower case optional
Baud Rates	300-9600	110-9600
Controls	Read to/from memory	Scroll up or down
Price (kit)	$149.95	$189.95

Above prices include all IC sockets

OPTIONS:

Power supply (mounts on board) $14.95
Video/RF Modulator, VD-1 . . . . . 6.95
Lower case option (TH6416 only) 14.95
Assembled, tested units, add 60.00



CYBERNEX

"TH 6416 shown above"

Frequency Counter
$89.95 KIT



You've requested it, and now it's here! The CT-50 Frequency Counter Kit has more features than counters selling for twice the price. Measuring frequency is now as easy as pushing a button, the CT-50 will automatically place the decimal point in all modes, giving you quick, reliable readings. Want to use the CT-50 mobile? No problem, it runs equally as well on 12 VDC as it does on 110 VAC. Want super accuracy? The CT-50 uses the popular TV color burst freq. of 3.79545 MHz for time base. Tap off a color TV with our adapter and get ultra accuracy—.001 ppm! The CT-50 offers professional quality at the unheard of price of $89.95. Order yours today!

SPECIFICATIONS

Sensitivity: less than 25MV
Frequency range: 5Hz to 60MHz, typically 65MHz
Gate time: 1 second, 1/10 second, with automatic decimal point positioning on both direct and prescale
Display: 8 digit red LED .4" height
Accuracy: 2 ppm, .001 ppm with TV time base!
Input: BNC, 1 meg ohm direct, 50 ohm with prescale option
Power: 110 VAC 5 watts or 12 VDC @ ½ Amp
Size: Approx. 6" x 4" x 2", high quality aluminum case

PRICES

CT-50, 60 MHz Counter Kit. $89.95
CT-50WT, 60 MHz counter, wired and tested. $159.95
CT-600, 600 MHz prescaler option for CT-50, add. . $29.95

MINI-KITS

FM WIRELESS MIKE KIT
Transmit up to 300' to any FM radio. Sensitive mike input requires dynamic, crystal or ceramic mike. Runs on 3 to 9 volts.
FM-1 . . . . . $2.95

TONE DECODER KIT
A complete tone decoder on a single PC Board. Features: 400 to 5000 Hz adjustable frequency range, voltage regulation. 567 IC. Useful for touch-tone decoding, tone burst detection, FSK demod, signaling, and many other uses. Use 7 for 12 button touchtone decoding. Runs on 5 to 12 volts.
Complete Kit, TD-1 . . . . . $4.95

LED BLINKY KIT
A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons or warning type panel lights.
Complete Kit, BL-1 . . . . . $2.95

SUPER-SNOOP AMPLIFIER
A super-sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as a general purpose test amplifier. Full 2 watts of output, runs on 6 to 12 volts, uses any type of mike. Requires 8-45 ohm speaker.
Complete Kit, BN-9 . . . . . $4.95

MUSIC LIGHTS KIT
See music come alive! 3 different lights flicker with music or voice. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300 watts. Great for parties, band music, nite clubs and more.
Complete Kit, ML-1 . . . . . $7.95

SIREN KIT
Produces upward and downward wail characteristic of police siren. 200mw audio output, runs on 3-9 volts, uses 8-45 ohm speaker.
Complete Kit, SM-3 . . . . . $2.95

POWER SUPPLY KIT
Complete triple regulated power supply provides variable ±15 volts at 200ma and +5 volts at 1 amp. 50mv load regulation, good filtering and small size. Kit less transformers. Requires 6-8V at 1 amp and 18 to 30VCT.
Complete Kit, PS-3LT $6.95

VIDEO TO RF MODULATOR
Convert any TV set to a video monitor. Super stable circuit is glitch-free, tunable over channels 4-6. Runs on 5-15V. Recommended by many computer manufacturers. Std. video input. Complete kit, VD-1 . . . . . $6.95

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MINI DIP 10/$2.00

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556	.75	340K-12	.99
566	1.49	7805	.99
567	1.49	7812	.99
324	1.49	7815	.99
1458	.49	78MG	1.50
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PNP Power Tab 40W	3/$1.00
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UJT 2N2646 type	3/$2.00
2N3055 NPN Power	75

RS232/TTL
TTL/RS232
Converter kit
Complete kit $7.95

IC SOCKETS

8 pin	low profile	5/$1.00
14 pin	low profile	5/$1.00
16 pin	low profile	5/$1.00
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14 pin	wire wrap	3/$1.00

ramsey electronics R8
Box 4072K ROCHESTER NY 14610 (716) 271-6487

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NEW PRODUCTS

Edited by Dennis Brisson

WRAPET 800 WTI

The WRAPET 800/WTI is a new wire-wrappping gun with several unique features. Even though it is ac operated, it is as light as most battery-operated guns. The feel and balance of the tool represent improvements over any other device I have tried, and, at $60, the price is extremely reasonable.

The WRAPET 800/WTI tool is different: Its cylindrical design allows you to point to your wire wrap with your trigger finger, whereas with other guns you must wave the point around until you find the right spot. With the 800/WTI, the actual trigger is toward the tip and hence the pointing. The more direct relation between pointing and the tip means fewer mistakes and less fatigue for the user.

The torque of the tool is surprising, since its weight is so much less than other tools. In addition, the tool's higher operating speed contributes to fewer "bum wraps." You can exert too much pressure and foul the wrap, but you really have to try, since the back-force sensing works quite well. Because of the operating speed of the tool, spiral wraps are difficult to cause.

The average hobbyist who has a need for wire wrapping can indeed afford the difference between the 800/WTI and its competition. Even if the lower-priced wire-wrap guns were as good, the 800/WTI comes standard with an unwrapping tool (there's even a little screwdriver for installing the bit). When you include this feature in the cost of the gun, the price is almost cheap. Furthermore, there are no batteries to buy or run down on Sunday night three wraps from the end of your latest project.

KEL-AM, Inc., PO Box 313, Eldon MO 65026.

Edward T. Tanton
Smyrna GA

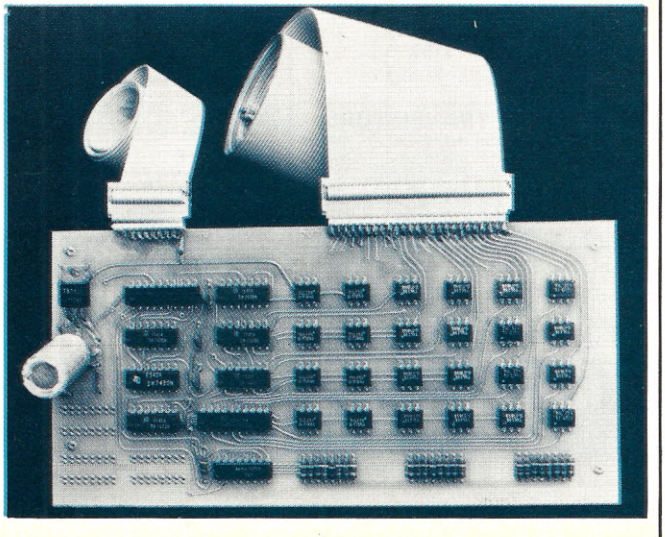
PET Control Board

The CTLR-216 is an interface card for use on PET computers as a process controller for medium-duty applications for stepper motor operated devices. The two 4-phase stepper logic outputs are provided with eight opto-isolated sense input lines and eight opto-isolated output control lines.

A software driver module containing eight commands that facilitate control of two steppers, eight heavy-duty relays, or triacs, and eight input sense lines is included. All commands, which include rate select, stepper move, limit switch inputs, relay control, position index and execution command, are passed by the user function in PET BASIC. The software module occupies 400 bytes and will run on any 8K, or larger, computer.

Power is supplied from computer transformer to on-board 5 V regulator. The 4 × 8 inch board comes complete with mounting hardware, parallel user port and control cables. Three extra IC positions are provided for custom additions. Options include: power control unit containing stepper power supplies, heavy-duty relays and I/O termination panel. Price is $199.

Nanco Diversified Design, 8380 Vickers Street, Suite E, San Diego CA 92111.



The CTLR-216.



The Memorite 2 system.

CBASIC-2

Version 2 of CBASIC is now available from Software Systems, PO Box 145, Sierra Madre CA 91024. CBASIC is a comprehensive, commercially oriented compiler/interpreter designed for use with the CP/M operating system.

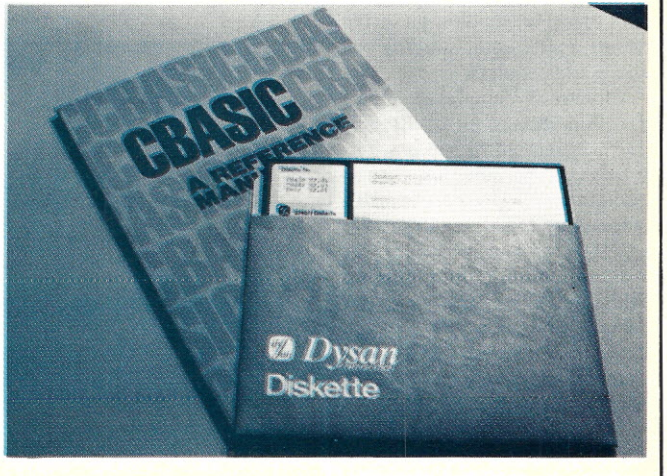
CBASIC-2 improves on the original version by adding integer variables, chaining with common variables, multiple line functions and a cross-reference lister for program variables. Intermediate files are smaller, and execution is faster.

CBASIC provides application programmers with a tool for developing large systems. With emphasis on modular design, maintainability, expanded control structures and source code security, CBASIC is the logical choice for implementing business systems.

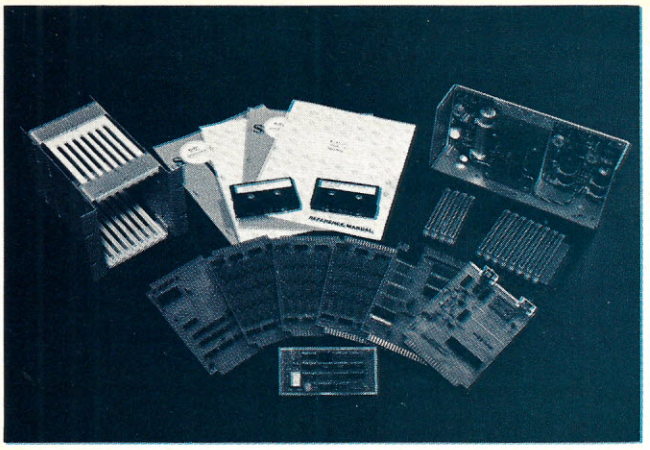
Word/Data Processing System

Memorite 2 is a video-based word-processing system capable of handling data-processing applications from Vector Graphic, Inc., 31364 Via Colinas, Westlake Village CA 91361. The system incorporates the firm's high-speed Z-80-based MZ microcomputer with 630K bytes of disk capacity, their versatile "Mindless Terminal" and the Qume Sprint 5, 55 cps printer.

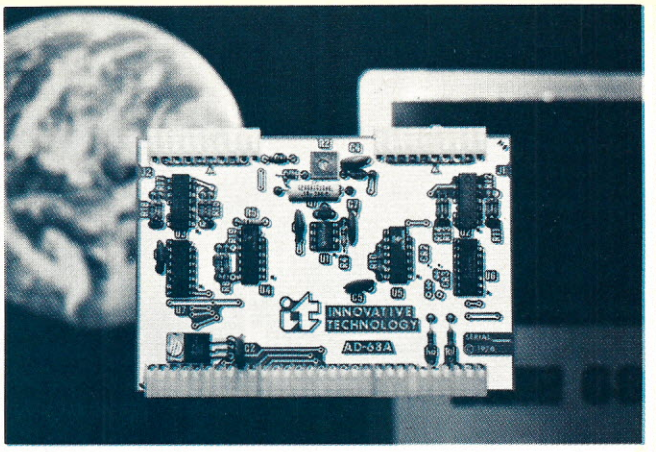
For word-processing applica-



CBASIC Version 2.



48K Development Pac II.



IT's AD-68A.

tions, Memorite 2, with dual Micropolis floppy disk drives, features advanced text preparation, edit and delete capabilities. It offers automatic letter printing from memory with full formatting techniques such as underlining, indentation, automatic margins and variable line/character spacing. The system also performs mass mailings, allowing letters to be merged with address lists. Its memory is resident on PROM, so users need only type after a "power-up and proceed" function.

As a data processor, Memorite 2 is capable of performing standard accounting tasks and custom applications in Business BASIC for small firms or departments of large companies. Scientific calculations are also available. The price is $8950.

Software from Speakeasy

Speakeasy Software announces software for the PET and the TRS-80, in addition to its Apple versions. The titles fall into two categories: the Continuing Education Series, which includes Financial Analysis and Transactional Analysis; and the Home Entertainment Series, with Warlords, Bulls and Bears, Sportstrivia, Microtrivia and Kidstuff.

Speakeasy Software Ltd., Box 1220, Kemptville, Ontario, Canada K0G 1J0.

6800 Development System

Wintek's new Development Pac II includes 48K RAM and an EROM programmer for $1895. Also included is an RS-232 serial I/O port with switch-selectable baud rates, 300 baud and 2400 baud cassette interfaces, an editor/assembler, industrial BASIC and all other items required to configure a 48K development system.

Wintek Corp., 902 N. 9th Street, Lafayette IN 47904.

Computer Enclosures

The Computer Enclosure CE-18 is a microprocessor case for the computer user who has a single board or multi-card system and wants to upgrade his stock metal/fiberglass enclosure. The contour-formed Royalite unit with its easily modified chassis provides for easy mounting—for connector-mounted multi-card or single card systems. The keyboard can be either self-supported or mounted on standoffs from the bottom of the case. Keyboard cutout is easily accomplished with power or hand tools.

You can mount external cords on the rear vertical section of the case. Standard color is walnut woodgrain. The 18 × 19 × 8 inch case costs $54.95.

JRF-Tronics, Inc., 1061 N. Shepard, Unit D, Anaheim CA 92806.

Analog-to-Digital Converter

The AD-68A is an eight channel analog-to-digital converter that occupies one I/O slot in an SWTP 6800-type computer. It allows the computer to measure analog signals from 0 to 2.50 volts with a resolution of 10 millivolts. The AD-68A uses a single ramp, elapsed time method of conversion with the computer providing control and counting functions through a 30 byte subroutine.

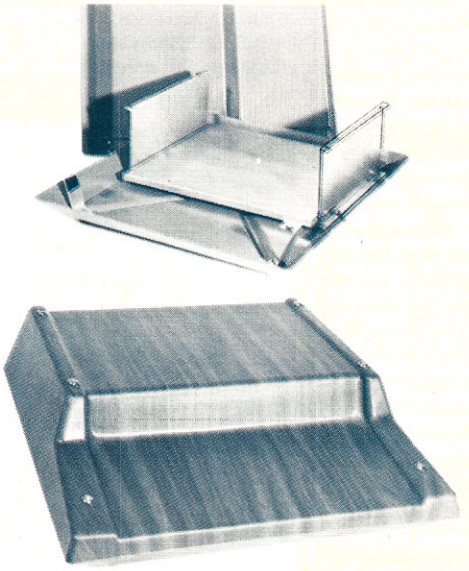
Unused analog inputs may be used to sense logic signals and switch closures. Regulated +5 volts and ±12 volts are available at the input connectors to provide power for external circuits.

The AD-68A comes with complete documentation including the driver subroutine, BASIC program example and schematic. Price is $39.95 assembled.

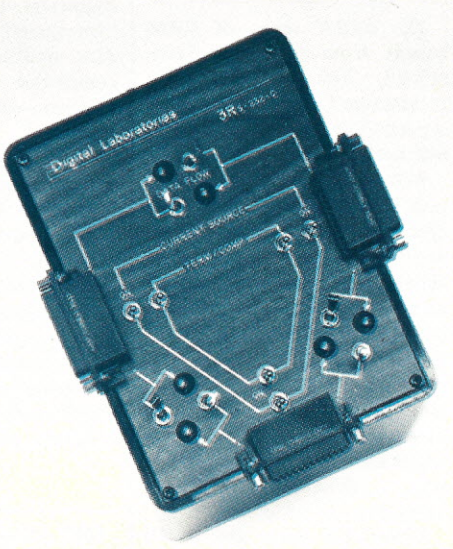
Innovative Technology, 510 Oxford Park, Garland TX 75043.

Computer Connection Box

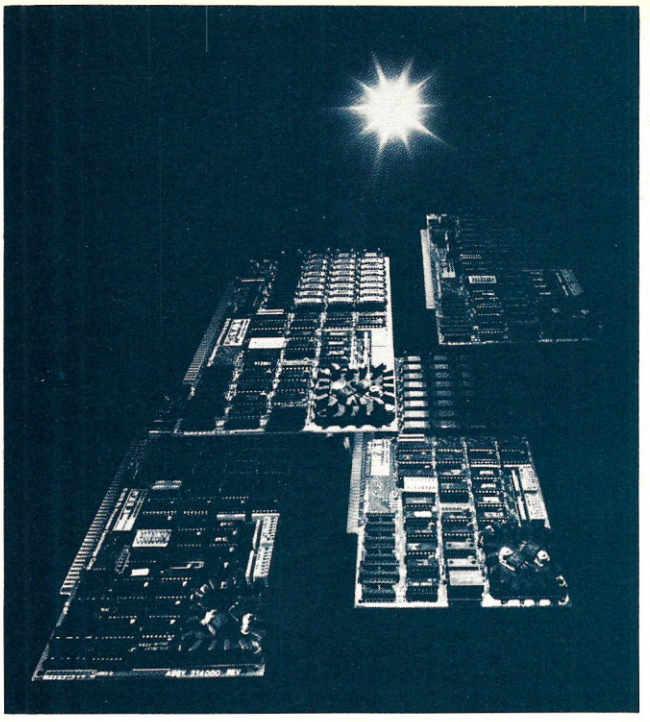
The Digital 3R Universal Junction Unit is a compact connection box that makes direct computer-to-computer connections possible, without software modification. It permits direct communications between serial devices. It incorporates three ports; each has switches to interchange transmit and receive signals and establish operation in the RS-232C or 20 mA mode. Additional switches provide 63



The CE-18.



The Digital 3R Universal Junction Unit.



PT's RAM board family.

possible communications connections between I/O devices.

The 5.3 × 2.3 × 7 inch universal junction unit has a built-in power supply and weighs only 3.5 lbs. Data flow is monitored by an LED, and transmission speeds up to 9600 baud can be accommodated. An indefinite number of communications connections are possible by connecting several units in series. The cost is $350.

Digital Laboratories, Inc., 600 Pleasant St., Watertown MA 02172.

16 to 64K RAM Boards

The nKRA series of RAM boards from Processor Technology, 7100 Johnson Drive, Pleasanton CA 94566, features capacities of 16K, 32K, 48K and 64K bytes.

Refresh is synchronous, so no wait states can slow the microprocessor. Switch-selectable addressing eliminates jumper wires and the need to power down when readdressing blocks of memory. Board design permits future incorporation of the bank select option. With bank select, memory may be expanded far beyond 64 bytes with all memory on-line continuously. Large programs, such as FORTRAN or PL/M compilers, can be loaded.

Worst-case access time is 400 nsec. Cycle time is 520 nsec. Power requirements are +8 to +40 V dc at 1 mA maximum, +15 to +19 V dc at 150 maximum and −15 to −19 V dc at 50 mA maximum. No power supplies need be regulated. Prices range from $429 to $1350.

Superchip for Apple

Enhance the text-processing capabilities of your Apple computer with Superchip from Eclectic Corporation, 2830 Walnut Hill Lane, Dallas TX 75229. The ROM firmware chip, which plugs into the Apple with no modification required, adds the full ASCII character set, including lowercase, plus 31 other non-ASCII characters. It also enhances editing capabilities for program and data modification. The chip is compatible with existing Apple programs—Integer BASIC and Applesoft.

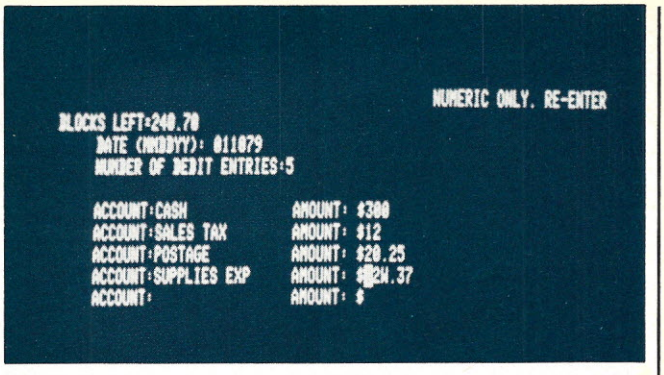
Used in conjunction with a special character edit cassette, also from Eclectic, Superchip allows you to define new characters in a magnified format. With this feature, you can create entire character sets, such as foreign alphabets (Greek, Russian, Arabic), musical notation and game pieces. Superchip costs $99.95; the character edit cassette is $24.95, plus shipping charges.

ADC Adapter Module for PET

Now you can directly connect the 16-channel Analog Input Module (AIM16) from Dam Systems to the Commodore PET with the Dam Systems PETMOD. This system provides easy-to-use and low-cost analog input for the PET; you can connect joysticks, potentiometers, temperature sensors, accelerometers, pH meters, etc., to the PET with minimal effort.

The PETMOD plugs into the PET IEEE port and PET user port to provide two PET IEEE ports and one user port in addition to the Dam Systems port. The PETMOD is also called the PETSAVR. Once plugged in, it can be left in, and you can use the IEEE and user ports on the PETMOD, thus preventing the fingers on the PET printed circuit board from becoming dog-eared. The PETMOD sells for $49.50.

Connecticut microComputer, Inc., 150 Pocono Rd., Brookfield CT 06804.



Skip-Sequential display.

North Star File Structure

Skip-Sequential is a file structure compatible with any microcomputer using North Star's Disk Operating System and BASIC. It eliminates the sequential-file requirement of reading through the file before performing a write operation to the disk. This improved speed is accomplished without having to resort to fixed-file records associated with random access files. Increased speed on all disk writes and disk space conservation result.

The new file structure has been incorporated into Ecosoft's new 70K General Ledger accounting package and is responsible for a data-file savings of almost 20 percent. The package is divided into 16 sub-programs so that hardware requirements are reduced to 11K of memory, 1 or more disk drives and an optional printer.

Each software package includes a program diskette and operator's manual. Prices range from $79.95 for the new General Ledger package to $500 for their multi-user CPA accounting package.

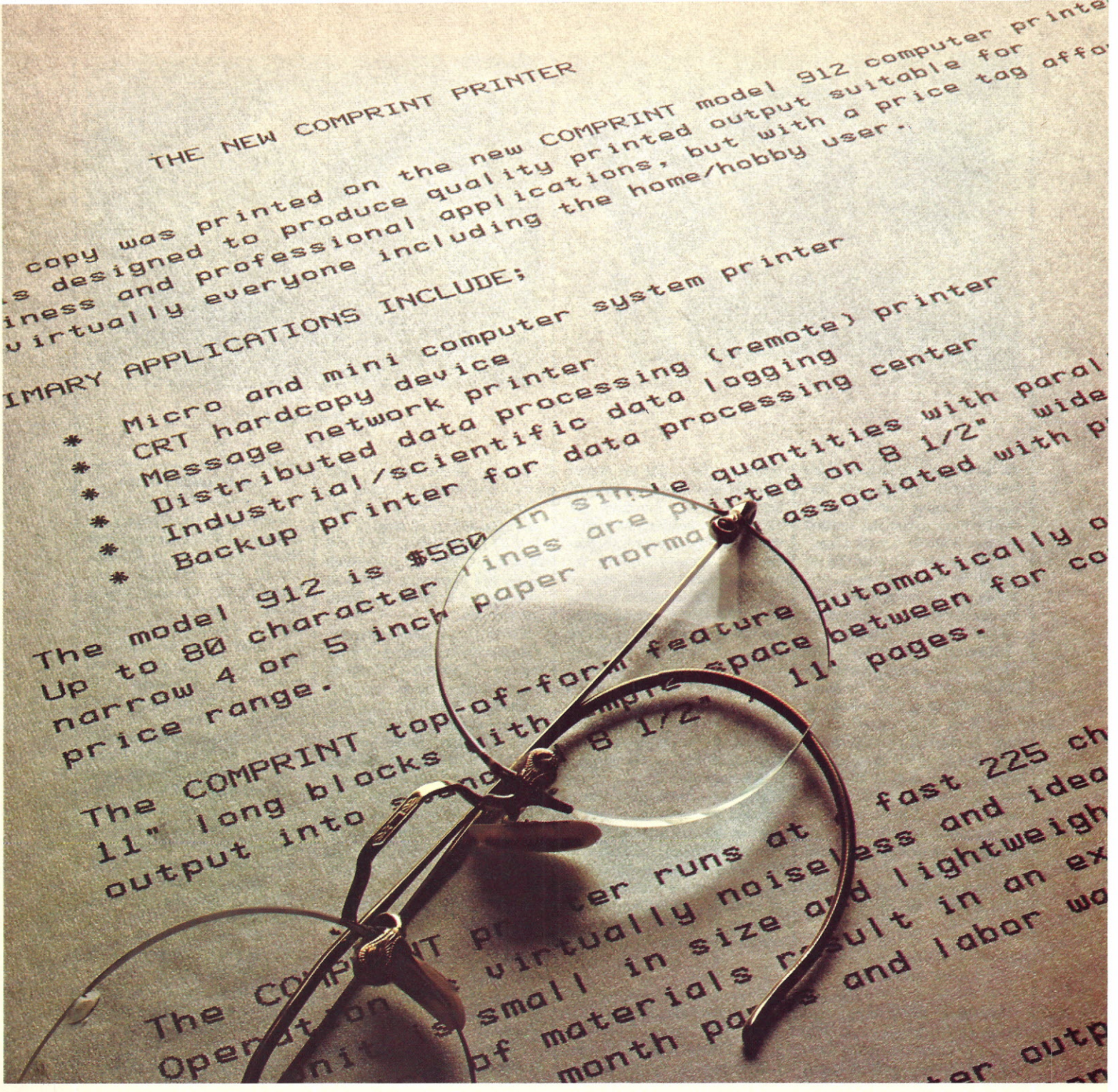
Ecosoft, PO Box 68602, Indianapolis IN 46268.

Printer Control Program

Bi-Direct is a new control program for the Diablo Hytype II printer. It takes the text output to



Superchip display.



This exceptional print quality for $560!

The new Comprint model 912 printer for computers and terminals:

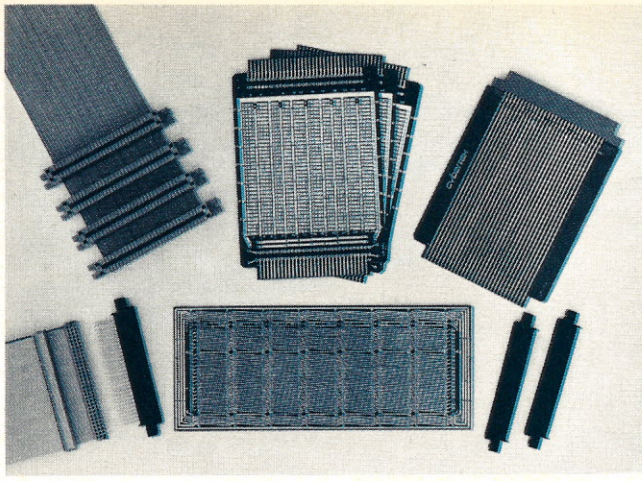
- Fast—225 characters/second (170 lpm)
- 80 character lines on 8½" wide paper
- Quiet, non-impact operation
- 6 month warranty

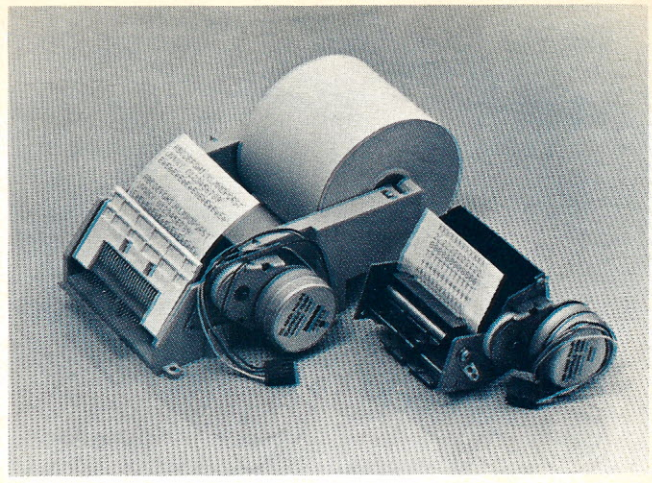


Available now at computer stores and industrial distributors.

comprint

Computer Printers International, Inc. 340 E. Middlefield Rd., Mt. View, CA 94043 • 415 969-6161





The PL20 and the PL12.

the list device and formats it for bidirectional printing. The formatting ensures that the printhead always moves the shortest distance possible to print a line.

The first release is available for the CP/M operating system and allows you to increase the printing speed as well as more easily control the printer functions.

Bi-Direct also offers easier control over spacing between the printed characters and the lines, along with changing the printing color from black to red at any time. Paging control and headers printed at the top of each page are also featured. Any or all of the functions of Bi-Direct can be turned on or off under user program control. It is shipped on an 8-inch CP/M format diskette and retails for $99.95.

Computer Services, PO Box 2292, Hickory NC 28601.

Circuit Design Aids

BreadBord kits are prototype design aids developed to simplify circuit design and building, testing and wiring without patch cords or solder. The kit models from Herman H. Smith, Inc., 812 Snediker Ave., Brooklyn NY 11207, are assembled on heavy-duty, glass epoxy boards, copper clad on each underside for ground plane. They feature color-coded, insulated binding posts and rubber mounting feet and a designated number of test points and capacities for multi-pin DIP ICs. Each of the kits is made to interface with meters, scopes and other devices and fits directly into Smith instrument cases for use as enclosures to accommodate additional circuitry.

The capability of each of the eight separate Bredbord models is detailed on the reverse side of each of the kit packages. Also provided is basic information for the BredStix and BredBlox elements, which are used in snap-in or snap-on form within the kits themselves to help expand or modify basic design concepts.

Prototyping Boards

The LP-12U Eurocard width (100 mm) universal prototyping card for microcomputer and other bus-oriented designs accommodates a dense mix of DIP-packaged ICs of all sizes (it will hold 20 16-pin DIPs). The 4 × 6 inch board has 60 gold-plated edgeboard connector fingers at each end for up to 120 off-board connections.

LP-12U cards can be interconnected without chassis wiring using one of Cybertek's two generalized motherboards: one for open-frame mounting on a 5 × 9.5 inch chassis and one for use with cardcages. Either style is available with 1 inch (8 position) or 0.625 inch (12 position) connector spacing. Prototyping boards can also be interconnected via the top-of-the-board connector using 60-conductor flat-wire cable and 60-position flat-wire edgeboard connectors.

The motherboard also accommodates wire-wrap sockets that permit bus extension to a second chassis by cabling between wire-wrap socket pins using 3M Series 3332 connectors and flat-wire cable. Extension cards are also available.

Cybertek, Inc., PO Box 3467, Seminole FL 33542.

Alphanumeric Printers

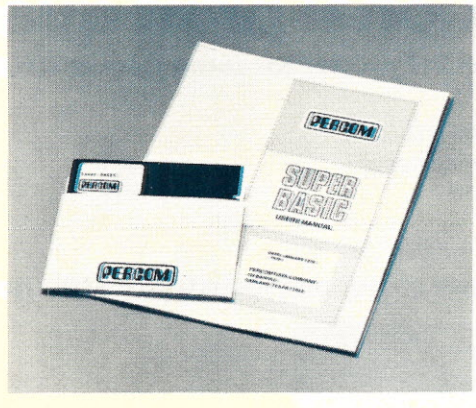
Bootstrap Enterprises of Richardson TX has merged with HOW Distributors of Houston TX to form American Micro Products, Inc., (concentrating its efforts on the rapid end-user buildup of Radio Shack computers). AMP offers two compact, lightweight, 5×8 dot matrix printers: the 12 column PL12 ($59.95) and the 20 column PL20 ($99.95).

A general specification manual, artwork for a printed circuit board (available only with the 20 column printer), parts list, flowchart and schematics describing the 8-bit parallel interface (Centronics-type) are included with each printer. In addition, the microprocessor control chip and the PC board (with the PL20) are available as options. These key elements of the interface are priced at $99.95 and $29.95 (with the PL20), respectively.

American Micro Products, 6550 Tarnef M/S 11, Houston TX 77074.



BredBord Kits.

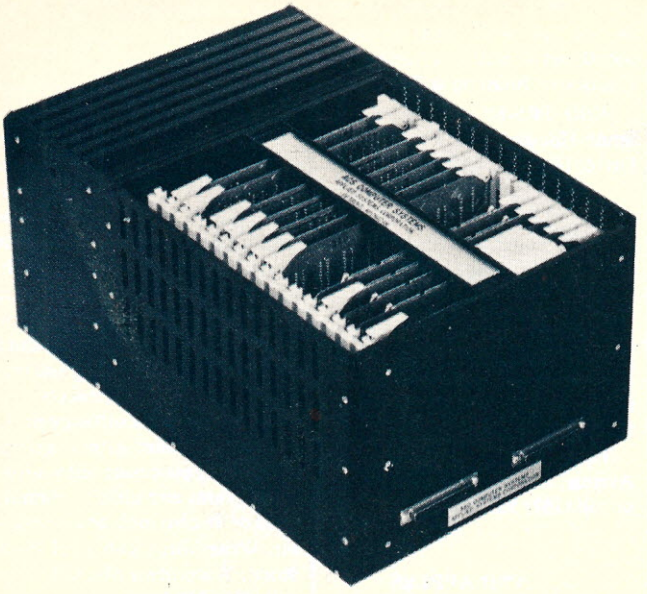


Super BASIC.

PerCom Super BASIC

PerCom Super BASIC is now available for 6800 computers using PerCom's LFD-400 or LFD-1000 mini-floppy disk systems. An extended disk BASIC similar in dialect to Southwest Technical Products' (SWTP) 8K BASIC, it supports 42 commands and 31 functions. The program requires 12K bytes of memory.

PerCom Super BASIC is compatible with programs written in SWTP 8K BASIC (versions 2.0, 2.2 and 2.3) and, besides addi-



ASC system.

tional commands and functions, includes refinements that reduce program run times by 35 to 40 percent. Other enhancements include: direct, random access to disk file data; optional use of the question mark (?) in lieu of the PRINT command; 9-digit BCD arithmetic; named disk file and batch processing capability when used with PerCom miniDOS; line and character position error reporting; and fast execution of function calls.

Upgrade kits for using Super BASIC with SWTP or Smoke Signal Broadcasting Company disk systems are also available. It is supplied on mini-diskette and, together with a user's manual, sells for $49.95.

PerCom Data Company, 318 Barnes, Garland TX 75042.

Data Acquisition System

The ASC Remote Data Acquisition and Control System provides extended logical/arithmetic and control programming capabilities, is expandable to over 256 analog input/output or controller functions and is uniquely adapted to distributed communications and data reduction operations as an integral system. Incorporating full digital computer and analog signal processing capabilities, together with compatible RAM and PROM memories, it can be used in process control, production monitoring, automatic testing or analysis applications.

It utilizes an LSI circuitry microprocessor featuring 8/16 bit architecture, a 1 usec instruction cycle, multi-level priority interrupts, fast multiply-divide arithmetic commands and interfacing for both high-speed analog-to-digital conversion and serial communications modules. The system permits utilizing interchangeable RAM memory and non-volatile PROM memory during the initial data acquisition software development, with the option of incorporating compatible low-cost ROM for final firmware implementation in multiple systems.

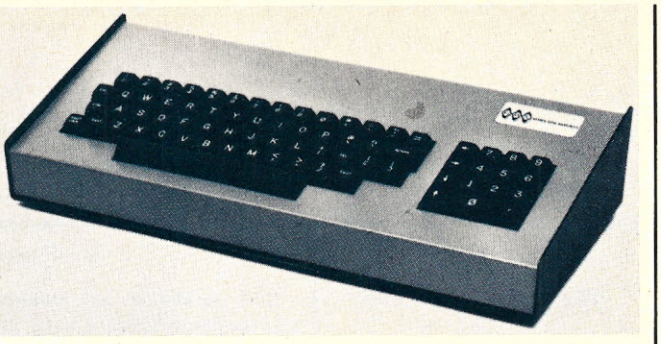
System design features include plug-in cards for the microprocessor unit, memory modules, analog and digital I/O and optional data displays, plus provisions for operator control panel and ac or dc power supplies.

Applied Systems Corporation, 26401 Harper Avenue, St. Clair Shores MI 48081.

64K Dynamic RAM Board

SupeRam is an S-100-bus-compatible 64K byte dynamic RAM memory board from Alpha Micro, 17881 Skypark North, Irvine CA 92714. It is completely compatible with the 16-bit Alpha AM-100 CPU. SupeRam is a high-density board capable of storing up to 65,536 bytes of data on a single board. It utilizes 16K dynamic RAMs to achieve maximum bit density, minimum power dissipation and optimum cost/performance ratio.

Refresh requirements are satisfied on the SupeRam board without support from the processor and, therefore, are transparent to the user. Exact and reliable internal timings are generated on-board using digital delay line techniques. Memory is addressable as independent 16K blocks, providing maximum capability with existing Alpha Micro systems.



The Model 771.

SBC-100 Single Board Computer

The SBC-100 Single Board Computer is designed for use without a front panel and replaces many lower-level CPU boards. At its heart is a versatile Z-80 microprocessor. A full single board computer, the SBC-100 offers features that allow it to be coupled with a controller interface to give a complete control unit for industrial applications.

Its features include: 1K on-board RAM, 8K bytes PROM (using 2716), RS-232 serial I/O, parallel I/O, four channel counter/timer, software programmable baud rate generator, S-100 bus compatibility.

SD Systems, PO Box 28810, Dallas TX 75228.

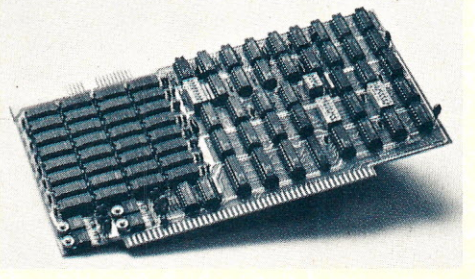
Model 771 Keyboard Subsystem

The Model 771 Keyboard Subsystem includes 56 alphanumeric keys that provide the entire 128 character ASCII set, including lowercase and a separate 15 key numeric/cursor control keypad. Utilizing a building-block approach, the 771 is easily customized and eliminates much of the hassle of a discrete keyboard.

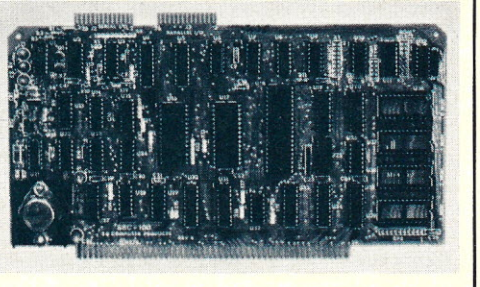
Four modes of encoding, including uppercase only with the Alpha lock key, allow convenient entry of data with high throughput. Four power-supply options allow use with any available supply voltage source. A versatile interface permits user selection of data, strobe and parity sense for proper operation with almost any system. Optional adapter mounts within the 771 enclosure convert the keyboard to a completely self-contained keyboard transmitter with 110-9600 baud RS-232 or current-loop serial data output.

Standard features include auto-repeat, two key rollover and fully buffered outputs. The 771 is equipped with a parallel interface and D series connector for easy interconnection. Non-glare, two-shot molded keycaps are also pro-

(continued on page 25)



The SupeRam.



The SBC-100.

CLUB CALENDAR

Steve Fuller

TRS-80 USERS GROUPS

Jacksonville IL

The Radio Shack store of Jacksonville has announced the formation of a users group for the TRS-80. According to Keith Hanson, the group's activities include publication of a newsletter, which is available by subscription for $11 per year.

Meetings are held on the second Thursday of the month and are open to all interested persons. For more information, write to the Radio Shack TRS-80 Users Group, c/o Keith Hanson, Lincoln Square S/C, Jacksonville IL 62650.

Battle Creek MI

Software swapping, hardware and tutorials are among the upcoming topics to be addressed by the recently formed Battle Creek Area Microcomputer Club.

Club spokesman Jeff Stanton says the organization is made up "largely, but not exclusively" of TRS-80 owners, and welcomes both beginners and more experienced hobbyists. Meetings are held on alternate Thursdays at 7 PM.

Write to Battle Creek Area Microcomputer Club, 8587 Q Drive North, Battle Creek MI 49017, or call Jeff at (616) 763-9685.

Goldsboro NC

The address of the recently formed TRS-80 Users Group is PO Box 753, Goldsboro NC 27530.

Houston TX

Kip Bartraro is president of the TRS-80 Users Group of South Houston, a new organization which "enthusiastically pursues hardware, software, business, scientific and recreational aspects of the TRS-80." The group meets on the first Wednesday of each month in the Bellaire Chamber of Commerce Building at 7:30 PM.

Write TRS-80 Users Group of South Houston, 10914 Bob White Drive, Houston TX.

San Francisco CA

TRS-80 owner or not—John Revelle invites hobbyists in the North San Francisco area to visit the Redwood Empire TRS-80 Users Group.

Write to John at 7136 Belita Avenue, Rhonert Park CA 94928, or call (707) 528-1464.

. . . AND APPLES

Research Triangle NC

Officers of the Carolina Apple Core Computer Club are president, Felix Clayton; vice-president, Gene Jackson; secretary, Bob Jackson; and treasurer, Wilbur Andrews.

Annual dues of $5 include a monthly newsletter and a developing software library as well as dynamic monthly meeting programs featuring "apple"cations.

For club information and software exchange, write Carolina Apple Core, 5212 Inglewood Lane, Raleigh NC 27609, or call (919) 682-3756.

Boston MA

The New England Apple Tree has taken root in New Bedford. The Mitre Corp Cafeteria is the meeting place of N.E.A.T. on the third Wednesday of the month. Owners and hobbyists interested in the Apple II are invited to join the group for software exchange and information-sharing and presentations by guest speakers.

The group has a software package that includes games, graphics, a word processor, educational programs and utilities. Annual dues of $6 also include a newsletter. Write Mitch Kapor, 31 Birch Road, Watertown MA 02172, or call (617) 926-3809.

This column is available for you to report on your club's activities such as regular meeting schedules, special events or programs, swap meets or any endeavor that will be of interest to your fellow hobbyists. If your announcement contains timely information, please send it at least two months prior to the date or dates mentioned in the announcement.

Club Calendar
c/o Steve Fuller
334 Sterling St. Unit A-3
West Boylston MA 01583

COMPUTER CLINIC

The Florida Educational Computing Project, which is supported by the State of Florida, has recently approved a project for the evaluation and implementation of a microcomputer-based instructional computing system. We are looking for education-oriented software, both CAI-type material and administrative support programs (e.g., film library inventory/control, word processing, statistical analysis, etc.). We do not have the funds to purchase any software at this time and would, therefore, be willing to certify the return or destruction of any program material loaned to us if necessary.

Because of the variety of possible computers these programs may run on, we would prefer those not too dependent on a particular hardware configuration or operating system (if one is required). However, we would like to hear about any such programs running on 6502, 6800 or 8080/8085/Z-80 machines.

The outcome of this project will be a catalog listing all the acceptable software packages we receive, their evaluation and their source of distribution. This catalog will be made available to all educational institutions in the State of Florida and to any other interested educational systems. Naturally we would like to share with those who contribute software for evaluation, possibly starting an exchange program among the participants.

Those who have software they wish to submit for evaluation and inclusion in our catalog or those who have questions concerning our project may please contact: Dr. Nelson J. Towle, Sarasota County Schools, 2409 Hatton St., Sarasota FL 33577.

Paul G. Bunnell
Lake Worth FL

In the past couple of months I have acquired and put into use TSC's Text Editing System, SL68-24, and their Mnemonic Assembler, SL68-26. Both of these documents are powerful software tools.

My complete system is an SWTP 6800, including the PR-40 printer. My wish is to marry the editor and the printer.

It would be wonderful if someone could devise a program, routine, patch or whatever else you want to call it to make this editor print out on the PR-40.

Will someone please put his knowledge to work and come up with the answer.

Steve Stanley
1 Whitney Rd.
Latham NY 12110

I have been having trouble with my SWTP CT-VM video monitor. When it is first turned on, the raster pattern breaks up in a horizontal direction. The horizontal-hold adjustment seems to have no effect. After the monitor has been on for about five or ten minutes, the raster pattern locks in and is stable from that time on.

I would rather try to troubleshoot the monitor than to ship it back for repairs and be without it for about a month, but I do not have the schematics. I have written to SWTP four times asking for the monitor schematics or the name of the manufacturer from whom I can get them. For some reason they will not send me what I have requested.

If anyone knows where I can

GOOD BUY, OEM's!



GOOD-BYE COMPETITION!

Since Intertec introduced its new INTERTUBE Video Terminal, a lot of OEM's (and dealers, too) are saying "good-bye" to their high cost, low performance terminals. The INTERTUBE is such a good buy that OEM's find it almost impossible to justify using anything else.

You'll say good-bye too when you compare INTERTUBE's price / performance ratio with any other terminal on the market today. Standard INTERTUBE features include: a 12" display in a 24 line by 80 column format, 128 upper and lower case ASCII characters, reverse video, blinking, complete cursor addressing and control, an 18 key numeric keypad, separate backspace, tab, shiftlock, local, on-line and print keys, special user-defined function keys, protected and unprotected fields, line insert/delete and character insert/delete editing, eleven special line drawing symbols, 15 selectable baud rates from 75 to 9600 BPS, half and full duplex operation, an RS-232 interface, and ... would you believe it ... there is more! A special "Status Protect" key allows you to enable only those features required in your system and "lock-out" all others, thereby assuring flexible operation in both "smart" and "dumb" environments.

By now you're probably becoming very uneasy if your last terminal purchase wasn't an INTERTUBE. Brace yourself. You're going to become sick! OEM's realize there are no hidden costs of ownership with the INTERTUBE. You can have all the performance you need without having to add expensive options. Standard user-oriented features are: an RS-232 printer port, "block" transmission modes, parity and baud rate error detection, a self-test mode, a 25th "STATUS" Line which displays the current status of the terminal, a transparent mode to simplify program debugging, and selectable display intensities for "easy-on-the-eyes" operation with minimized operator fatigue.

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get the schematics, please let me know.

Buren R. Shields
900 Idlewilde Ln., SE
Albuquerque NM 87108

I have a number of Intel 3601-1 PROMs I cannot use because Intel has refused to answer my two letters offering payment for directions on how to program them. Because I am a comparative newcomer to computers, I am not able to contact the proper sources and will be glad to pay for programming help in the form of a circuit, parts list and complete directions.

R. B. Collins
1304 East Ave. I, #41
Lancaster CA 93534

I need help with the following problems. I have a PDP11/04 computer with 4.5 megabyte disk storage and an LA36 printer terminal. I would like to correspond with other PDP11 fans and computer clubs in order to exchange programs and circuit layouts.

Alexander Heyn
Sautierstrasse 73
D-7800 Freiburg
West Germany

I can no longer use my telephone-company vibrator/talker and have heard of a computer board being developed that allows you to push buttons, and it will form words through a speaker so you can talk on the telephone. I believe it has about 200 words at this time. Don't confuse this with the "kids learning to spell" unit or the foreign-language converter that spells out on LEDs. What I'm referring to just talks for those who have no voice.

If you know of such a unit, would you please send me address(es) so I can write for information.

Herbert H. Freeman
4522 Hamilton St.
San Diego CA 92116

LETTERS

Product Support

I must inform your readers about the excellent product support offered by Smoke Signal Broadcasting. I needed a reliable disk system to operate with my SWTP 6800 to aid me in my doctoral research, and after considerable reading and study, I decided on the SSB BFD68-2 because of the quality of their software and the excellence of their controller-card design.

Upon getting the system, I began getting frequent non-recoverable read errors, which was disastrous to my research. The store from which I purchased the system could offer little help over the phone, but SSB came through. Not only did they offer meaningful help over the phone (and even followed up their help with phone calls to me at their expense), but they even sent me a replacement controller card to help me isolate the problem. They were genuinely interested in my problem and spent a great deal of their time trying to help me.

Although I eventually gave up trying to find the apparent intermittent myself, SSB did find it when I finally sent the system to them for help. Somehow (and perhaps with good intentions) the store from which I purchased the system had replaced both of the original drives in the mainframe with older and evidently unreliable drives. This could have been a disaster for me, and I'm sure that had it been any one of several other companies that I've dealt with in the past I would have been left alone to fend for myself with a small-store owner located 400 miles away who claimed he was sorry but could not do anything to help.

As it turned out, however, SSB replaced my entire system and decided to deal with the store owner themselves. I don't know whether or not SSB will end up losing money on my particular sale, but the important point that I think your readers should be aware of is that this company did not leave their customer holding the bag. I think that such action says a lot about the integrity of Joe, Rick and Roger and the rest of the crew at Smoke Signal Broadcasting. I highly recommend this company to anyone looking for a high-performance disk system to go along with his 6800 microcomputer.

Terry Mayhugh
Concord TN

Where's The DG?

I've been a "Kilobaudian" since the very first issue and remain an avid fan of the magazine. But, being an owner of a Digital Group 8080/Z-80 system, I have to ask why there aren't more articles on The Digital Group's equipment. I can't understand why, after nearly three years of owning my system, I can count the articles written about it on the fingers of one hand.

Although I have recently purchased a PET, it does not match the versatility and ability of my Digital Group system.

It seems that the major computer magazines are swamped with articles on the PET, TRS-80, etc. Let's keep things in proportion and give a fair shake to the underdog—before we all slip through the cracks in our keyboards.

Geary Kelch
N. Linthicum MD

It's no secret that The Digital Group is in big trouble. That's too bad, because the company was once in a position to be a leader in the microcomputer industry.

The downfall of TDG stems from their insistence that TDG be the sole supplier of hardware and software for TDG systems. The company did all it could to assure that this would happen by refusing to adopt a commonly used bus and by being very reluctant to reveal pertinent data about its own bus and timing standards. This effort to corner the market meant that, unlike the S-100 owners, TDG owners had to rely on a single supplier for all accessory boards and software. In the end, TDG could not handle the vast expense of developing all *the hardware and software that microcomputerists were demanding.*

As development costs skyrocketed, some buyers of TDG hardware were left holding the bag. A classic example is the fellow who purchased a particular TDG peripheral and was annoyed when it arrived without the promised software driver routines. He called TDG's software department, where a beleaguered programmer told him, "Gee, are they selling that thing already? We haven't even started writing the software for it." This is not an isolated case.

Financial woes mounted until the company went into receivership. A reorganization is now being attempted, but only time will tell if that's possible. In the meantime, is it really fair to tantalize readers with tales of equipment that may never again be available?—Jeff DeTray.

The Micro Scene in Australia

Greetings from "Down Under." Have just had my first read-through of January and February 1979 *MICROCOMPUTING* and will now settle into a more thorough study. Congratulations on the new-look front cover. Trust you won't run out of suitable subjects.

I follow with great interest comments from Wayne and other industry commentators and can only echo your sentiments. Although our much smaller population in Australia means a much smaller number of potential end-users, there is quite a variety of systems being used here.

SWTP equipment has proven very popular. My own home-built system is based on the SWTP boards. I run a CT-64 Video Monitor, 32K RAM and twin SA400 drives. I should in fairness point out that up until now I have been the manager of Melbourne Silicon Valley, where among other items I have leaned heavily toward SWTP. Our shop is primarily a component outlet with a limited emphasis on microsystems.

In Melbourne, a fairly large proportion of all systems is in the possession of hams and/or engineering people who can't say no to a system. North Star, Cromemco, AppleSoft and, of course, TRS-80 are about the next most commonly known names.

A lot of schools are joining the rush, but regrettably there is no coordination as far as processors used is concerned. The result, I'm sure, will show up soon.

The local electronics mags have devoted a fair percentage of their content to uPs, concentrating mainly on SC/MP and 2650 as

well as VDU kits, both hardware and software oriented.

One of our biggest problems here is finding someone who handles a particular product and can supply from stock. Invariably it's money now, and then an order will go to the U.S.A. Not encouraged. Also, a lot of advertisers don't reply to correspondence, and I can't believe the Postal Service can lose so much mail as is often claimed.

Once again, thanks to you and your staff and, of course, your contributors.

G. Atkinson
Victoria
Australia

Changing Code

In response to Ancelme Roichel's letter (March 1979, p. 22), it seems that his memory has become a little rusty over the years since he developed ASCII. That's OK, though, since my copy of the X3.4 lists 87 people who participated in the development of ASCII, and it doesn't list Mr. Roichel.

According to Federal Information Processing Standard One (FIPS-1), which is a specially printed copy of ANSI's X3.4-1968, the character set is seven bits. It also states that no related larger or smaller sets are recognized by the standard, although it admits that they are possible. Small subsets (from 16 to 96 characters) were defined in FIPS-15, but, as far as I know, there was no ANSI document in support of that FIP. I seem to remember that there was a later proposal (possibly standard) that provided several different expansions for special purposes, but it is not in my library. X3.32 of 1973 provides some standards for graphic representation of control characters on line monitors, etc., but this has no application to the micro world.

Now, the ASCII vs USASCII debate caused me much heartburn in trying to get my documentation past the standards reviews and editors. As a result of my digging into the matter, I believe that either is acceptable, but that ASCII is preferred, as it was at the beginning. It seems that at one point the matter threatened to become an international incident, since some of our beloved neighbors were irritated by the U.S. putting out "American" standards without consulting them. During this period, it was felt to be good statesmanship to refer to our standards as USA standards rather than American standards. I guess some kind of arrangement was worked out, since the problem didn't last too long. My copy of X3.16-1966 refers to USASCII consistently, but my copy of X3.25-1968 uses ASCII. It looks like the change was a rather hurried cut-and-paste job, so I would guess that 1969 was when we went back to ASCII.

If ASCII do not cast shadows, that would make them ghosts, I think. I don't know, they aren't in Random House, and even Webster's is too rich for me.

James C. Matthews
Montgomery AL

ASCII Answer

Back in the dark days of March, we ran a letter from Ancelme Roichel (p. 22). In that letter, Ancelme said: "ASCII are people who cast no shadow—Webster's Unabridged. *" Since there isn't an* Unabridged *in the entire town, and since we only have* Collegiates, *we said: "If anyone can translate this transcendentally cryptic statement, let us know."*

Well, we received an answer from ascii (pronounced "ashy eye") in Milwaukee (we say "ascii" because there was no return address on the envelope). According to the Unabridged, *ascii is the plural of ascian, "one who has no shadow."—Editors.*

Many Manageable Dots

The raster-scan graphics by David Koh, M.D., in the November and December 1978 issues filled a real need for the 50-pin bus. Articles such as this make *Kilobaud MICROCOMPUTING* the most anticipated of my micro monthlies.

I used the circuit with a CT-64 terminal. It is related closely enough to its predecessor, the CT1024, that parallel points are easily derived. I have listed these correlations in Fig. 1. Note that the divide-by-two connection for the dot clock is necessary. For the extra chips needed, I simply "piggybacked" a couple of 7400s and a 7474 onto existing terminal ICs.

Used with the CT-64, the graphics provide 256 × 208 resolution on virtually a full screen. They require an additional 1.5K (for a total of 6.5K) of memory for support. Unwilling to buy an 8K board, I extended the author's piggyback method to a total of 24 2l102s added to the basic 4K board. Pin 3s were connected to GIC17d through GIC13a, presently unused, and the pin 13s of the additional 2K went to MIC23, pins 10 and 9.

Finally, GIC17d was labeled incorrectly on the schematic, which perplexed me for quite some time. Pins 11 and 12 should be input, and 13 output to GIC13 (see Corrections, p. 135).

My thanks to Dr. Koh for making these half-a-hundred-thousand dots manageable in the second half of his article.

William C. Lee
Chula Vista CA

Signal	CT1024	CT64
Lockout	TIC18/P4	same
Dot Clock	TIC11/P6	same (add *1/2)
Linecount Reset	TIC12/P13	IC20/P1
Blank	TIC5/P2,5	IC5/P5, IC20/P12

CT64 video leaves IC31/P8 for IC17/P12,13 (which equates to CT1024).

Fig. 1.

The Students' Choice

I agree with David L. Whelchel's letter (March 1979, p. 20) calling for the reinstatement of the TRS-80 Forum. As you are no doubt aware, many school systems such as ours have turned to the TRS-80 as an economical and viable approach to incorporating the microcomputer into their instructional programs.

We sampled the PET and Apple, but the TRS-80 won the toss and proved to be the most cost-efficient approach for most school systems. Just think of the thousands of school children in grades K-12 across the country who are now having hands-on computer experience with the TRS-80. Radio Shack has realized this and is now conducting workshops for educators and businessmen. This, however, is not enough.

As an educator I need a condensed source of updated information to continually help improve instruction. The TRS-80 Forum is just the answer to such a requirement. The PET and Apple, etc., are nice at home, but just look around. It's the TRS-80 that has quietly involved the educational system, and Radio Shack realizes that it is sitting on a marketing gold mine.

Robert Harvey
Math/Science
Instructional Specialist
Campbell County Schools
Rustburg VA

The TRS-80 Forum was a casualty that has been badly missed by all of us. I'm sure most readers would like to see a regular column that could keep us up to date on new accessories, modifications, gadgets, programs, etc., for the TRS-80. There is enough information developing about this system to keep a dozen newsletters going, so why not distill the best of this information and have it in MICROCOMPUTING?—*Wayne.*

Apples Keep Rolling

In response to Robert M. Richardson's letter condemning the Apple (February 1979, p. 20), I would like to say that his opinion is probably based on very little knowledge of the machine itself. It is easy to criticize that which you know nothing about, and I can assure you that anyone who has taken the time to learn about the many features of the Apple can tell you that it is dependable, fast, versatile and colorful.

Radio Shack cannot cite any of the above qualities for its computer. Letters and articles continually appear in *Kilobaud MICROCOMPUTING* presenting brand-new hardware and software bugs in the undependable machine. The Apple, in a counting loop from 1 to 10,000, actually ran faster than many of the other "higher-performance machines," including, I might add, the TRS-80. As for versatility, any interfacing for peripherals which Radio Shack itself doesn't offer is virtually impossible. At present I have an ASR-33, keyboard-controllable servo motor and a real-time interrupt plugged into my Apple.

Of course, the capability of displaying color puts the Apple into a class by itself. The sophisticated software to back up the capability assures it that it will never fall into the "pseudo-graphics" category, as machines like the PET have. And, of course, there is no

end of possibilities for programming using either the low-resolution or high-resolution graphics modes.

In fact, I'm inclined to believe that most TRS-80 owners are TRS-80 owners simply because they failed to research the computer market well enough before buying.

Thomas Knox
Chappaqua NY

I must take exception to Mr. Richardson's comments on the Apple II computer. I agree that the article he alludes to was faint praise for the Apple II. I take exception to his statement about this product being "bereft of features." The features offered by the Apple II are simply different from those of the TRS-80 with Level II BASIC.

When I was contemplating the purchase of a microcomputer, several of the features available on the Apple II won me over. These features are obviously not the same as those desired by Mr. Richardson. A few of those features which attracted me are:

- The potential to expand the memory to the 48K limit within the existing cabinet.
- The portability of the unit, along with the potential to connect to any available TV as well as a monitor.
- Eight available I/O ports (exclusive of the game and video ports) easily accessible both physically and through programming (in either BASIC or machine language).
- The speaker for generating warning signals in programs, vocal communication, music and sound effects for games.
- A floating-point BASIC ROM (FP ROM) that seems to possess all of the capabilities of any other FP BASIC in a ROM and, in addition, has an easily executed, high-resolution color-graphics feature.
- Finally, the most important feature in any computer is its associated documentation. The Apple II has not yet failed me in that area either. The Apple computer people have provided the necessary hardware and circuitry description as well as software instruction that allows flexibility in the use of the computer. They even provided a machine-code routine and instructions for interfacing a serial printer with the existing hardware. The information contained in the Apple II owner's manual was crucial to my decision on whether the Apple II was able to meet my needs.

While I understand and appreciate Mr. Richardson's affinity for his favorite home computer, he should understand and appreciate that those of us who purchase Apple II computers—or any other make for that matter—have different needs and objectives for our machines.

The manufacturers of the various home computers, at this time, are trying to meet a largely undefined set of needs. I am sure that Mr. Wozniak of Apple appreciates any product improvement recommendation regarding the Apple II. (There was with my Apple II an enclosed card for that purpose.) To the best of my knowledge, my Apple II lacks nothing that the TRS-80 with Level II BASIC has, and it possesses some features that were very attractive—slight cost differences not withstanding. It is not "bereft of features."

In conclusion I would like to suggest that (1) *Kilobaud MICROCOMPUTING* refrain from publishing derogatory comments on various computers from non-owners of those units (this would allow latitude for legitimate discussion on product features from those in a position to assess them) and (2) home-computer owners write in and discuss their particular make, the features they like, the features they have little use for and what they would like to see in the future. In this way the manufacturers of home computers will better understand how their products might be improved to meet the market demand.

As can be seen through this letter and Mr. Richardson's letter, the wants and needs of the buying public remain largely undefined, quite diverse and continue to fluctuate. Right now, however, the Apple II with the FP ROM amply meets my near-term future needs in a home computer.

Ray H. Bazil
Waldorf MD

Re: my letter, February 1979, p. 20, regarding the cost-ineffectiveness of the Apple computer. For the edification of those Apple devotees who have written and called me on the subject, a few final comments:

1. If you wish to draw color pictures, buy crayons.
2. If game playing in living color is your thing, buy a Monopoly set.
3. Throughput, per dollar investment, should be a major decision-making factor. If so, a Level II TRS-80 beats all contenders "hands-down" by a factor of nearly 2:1, and even more so when running the Z-80's clock at 2.5 MHz and up.
4. We have two TRS-80s with mini-floppies. The first is used exclusively in our microwave security-systems laboratory for both R and D and system test. It has contributed significantly in both reducing routine engineering workload and in final system checkout and test. In the latter function it has effectively replaced two full-time technicians who now apply their skills in the prototyping lab. The second TRS-80 is at home where it serves as a character-oriented word-processing system using the Electric Pencil and a Western I/O Selectric printer. In this function it replaces a $10,000 IBM Mag Card Reader used in our textbook writing avocation (*The Gunnplexer Cookbook*).

The main thrust of my Apple comments was that it is not a cost-effective, competitively priced system. If this infuriates Apple lovers, so be it. If music research in living color or arterial blood flow in bright "red" is your thing, the Apple is for you. "To each his own, and thank goodness for free enterprise," said the old man as he kissed the cow!

Robert M. Richardson
Richcraft Engineering
Chataqua NY 14722

This column is designed to serve as a forum for all viewpoints. Readers, whether you like or hate your system, put it on paper and let's see it—we might be able to shake something of interest loose.—Wayne.

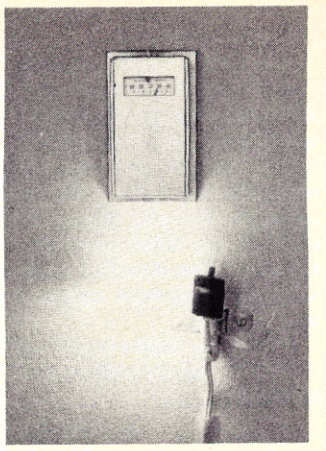
Thanks

As author of the Heathkit BASIC Programming Course, I'd like to thank George Knoll for his review in the March 1979 issue of *Kilobaud MICROCOMPUTING*.

Willard I. Nico
Houston TX

Let There Be Light

I received my copy of the February 1979 issue yesterday and, as usual, I put aside several other tasks so I could read it cover to cover. Although I'm still a long way from understanding most of it, a little more soaks in with each issue. Compared to a year ago, however, when I received my TRS-80 Level I 4K and tried my hand at programming for the first time, I feel far ahead of the general populace and am at least able to hold a conversation with other computer enthusiasts.



Night light on.

Several articles in particular caught my eye. The "TRS-80 Level II Reference Manual Index" is a real "find," far more detailed and thought out than a couple of others I've run across. I've had Level II for about two months now, and many of the commands are still very puzzling; this index should help immensely. "Attack On the Pack," showing the inside circuitry of the TRS-80 power pack, was also of great interest.

However, I have to offer my personal award for computer-overkill to the "Computerized Climate Control" story. This is sure the hard way to do something simple! For several years I've used a regular night light (4 or 7 Watts) placed under the thermostat, turned on and off as desired by a Westclox 24-hour multiple program timer (model S45-52019—Westclox, LaSalle IL 61301). The timer, which only cost me about $7, plugs into any outlet and has three sets of on-off trippers that plug into any of 48 holes (30 minutes apart) on the 24-hour dial face. How simple can you get?

You simply set the timer to turn on the night light about the time you want the thermostat to think the house is warm enough, and have the timer turn the light off about 1/2 hour before you want the heat to come back on. You can perform this "furnace fooling" several times a day, just as described in the article, at far less cost and without the incredible complexity described in the article. Incidentally, AMF also makes a multiple timer called the "Touch Command" with 24 hourly spaced buttons on the circular dial. Also, for several years, several single-cycle devices, such as Fuel Miser and Fuel Sentry, have been available. They use a plain 24-hour plug-in timer con-



Timer control for night light.

nected to a resistor placed beneath the thermostat. I much prefer the night light, since it provides a positive indication of operation, and gives light at night!

Fred Blechman
Canoga Park CA

Super Software

I want to share some pleasant mail-order experiences with your readers. All too often, we only think to mention the bad things that happen to us at the hands of a remote supplier; the "good guys" are not rewarded properly.

I purchased various SWTP kits just over a year ago from a Boston dealer—but at the time I lived in New York, so that was more or less local. For the next several months, I wrestled with the very mediocre software available from SWTP, suffering with the sort of quirks and defects described in Joseph O'Loughlin's letter in the February 1979 issue, p. 20. Gradually, I achieved working status for the CORES assembler, but never managed to obtain proper runs with either the 4K or 8K BASICs (bad tapes, as verified by several other hobbyists and a couple of dealers); SWTP was no help at all.

Now, for the good part. Frustrated, I finally responded to an ad in a magazine, sending off $29.95 for Computerware Software Service's cassette-oriented BASIC. It loaded every time I ever ran it through the player, ran beautifully and gave me the opportunity to share the learning experience with my daughter.

Subsequently, I have purchased the Smoke Signal BFD68-2 disk system from Computerware, as well as several terrific software packages. My inexperience was neither an impediment nor the cause of any ill will toward Computerware. They have responded immediately to every inquiry I have had occasion to initiate—telephone as well as letter—with friendly, attentive assistance. My contacts have stemmed from misunderstanding the documentation, a bad sector on a software disk and what proved to be a hardware problem. Paul Searby and his staff never once showed any reticence in assisting me through the problems, and I wholeheartedly commend them for their excellent performance. You may be sure that my future purchases will be made through this fine organization if they sell what I need. I hope others will be encouraged to try them on the strength of these words.

Charles D. Shilling
Fort Worth TX

For Shame!

First—thank you for recent articles on the 1802 . . . no less than three in the February 1979 issue alone!

My system is based on the Elf II but has been entirely hand wire-wrapped to be S-100 compatible (including dynamic RAM; I have tried a friend's dynamic RAM to check this) with 16K RAM, 8K EPROM and EPROM burner. So I'm partial to articles about the COSMAC.

However—shame on you! In your editors' note on page 38 you state that Tom Pittman's Tiny BASIC is only available from him on paper tape at $5 . . . wrong! He also wrote Tiny BASIC for Netronics Elf II. This is available for $14.95 from Netronics on cassette. You have their ad in the same issue on page 145!

Barry Erick
Dallas PA

Sorry. The note was obsolete; we should have modified it.—Editors.

TV—Bad for the Mind
CRTs—Not Bad for the Eyes

In his article, "Is Your Video Monitor Dangerous?" March 1979, p. 52, Sherman P. Wantz has raised a question, obtained information from some excellent sources and concluded: "The experts' opinions that video terminal viewing is not injurious to our health has to be regarded as reassuring" . . . then, announces, "We are left in limbo." Quite frankly, I am tired of people like Mike Wallace, whose staff may have spent a few months or so asking journalistic questions, being considered qualified as experts compared to people like Dr. John Villforth and Dr. Charlotte Silverman, who have spent full careers of deep study. The body of experimental evidence leads to the single conclusion that viewing video monitors does not present a health hazard from x-radiation. Even a person who spends his entire workday before a CRT screen is safe.

Using relatively simple calculations, it is possible to show that a standard 2000-hour work year would result in an annual dose of $(1.7 \times 10^{-11}$ rad/hr$)(2 \times 10^{3}) = 3.4 \times 10^{-8}$ rad/yr.

This estimate does not take credit for any lead glass on the face of the CRT or the presence of an optical filter, both of which will attenuate the radiation further, and assumes a full-up brightness control.

Compare this estimate to Dr. Silverman's threshold dose of 200 rads for cataract induction. Or compare it to our normal radiation exposure of 0.1 rad per year from cosmic radiation, terrestrial sources and natural radioactivity in our own bodies. Or compare it to a dose of 0.2 rad from a chest X ray. Cataract induction simply does not occur from doses at these low levels.

If you still do not believe there is no hazard from X rays while you view your TV monitor, try this experiment. Obtain two dental film packs from your dentist. Bend two letter Ms and two letter Bs from 18-gauge copper wire and tape a letter M and B to the front and back of each film pack. Hang one of the packs on a wall, with the M outward, well away from the monitor, and tape the other to the face of the monitor with the letter M facing against the screen. Identify the pack on the monitor by writing an X on it with a grease pencil or china marker. After a month, have the films developed by the technician at the dentist's office, making sure that the monitor film and control film will not be mixed up. If you can distinguish the letter M on the film which has been taped to the monitor, the CRT may be defective and should be checked professionally. No TV set I have ever checked has produced a visible image, even though the film is easily capable of detecting 0.005 rad.

I am a newcomer to microcomputing. I have had access to an SWTP system for only about a year and a half—but I have almost 30 years' experience in the nuclear field, the last 15 as the radiation-protection officer for Louisiana State University. I have written a variety of radiation-safety programs for my system, have enjoyed using it and never worry about X-ray exposure while I am at the console.

Robert C. McIlhenny, PhD
Baton Rouge LA

NEW PRODUCTS

(from page 19)

vided. Basic keyboard assembly is also available for custom installation in a user-supplied enclosure. Fully assembled and tested, the 771 is priced from $150.

George Risk Industries, Inc., GRI Plaza, Kimball NB 69145.

Micropolis Software

Software for the Micropolis minidisk system is available from Basically Speaking, 719 Anna Lee Lane, Bloomington IN 47101. The first three program offerings from the company include:

Statpak—allows you to create a data file and perform multiple statistical analyses on a data base. Statistical functions include: chi square, Anova, linear regression and several other popular programs.

Gradebook—allows school teachers to use their computer as a gradebook. Multiple classes are allowed, as well as missing assignments, excused absences, addition and deletion of student records. A grade-figuring program (Reportcard) that may be run at any time during the semester is included.

PAL—(Personal Accounts Ledger) is unique in that it not only keeps a checkbook ledger, but also a savings ledger, a small-business ledger, an investment ledger and allows these ledgers and their accounts to be fully integrated. Selected account printing is also supported.

The price for each diskette is $45, which includes a Micropolis MDOS (Mod I or Mod II) or Micropolis CP/M (BASIC-E) diskette and documentation with full instructions for use, suggestions for modifications and complete listings.

R. M. Law
D. C. Mitchell
5521 Woodward
Downers Grove IL 60515

A Text Formatter in BASIC

This companion article to "(Con)text Editor" (September 1978, page 22) describes a text-formatter feature that can be added to the editor to form a capable subsystem.*

For those of you unfamiliar with computerized text formatting, it is basically a system that takes raw text in rough-draft form and produces a final document. When formatters were first introduced, they were essentially nothing more than automatic typewriters, and the full power of the computer was not realized.

Today, however, such systems represent a higher generation of sophistication and provide the user with many new features and conveniences. The distinction brought about by these advances is that in computerized text formatting the user does not have to actually format the document; rather, he merely supplies the computer with text and some formatting instructions.

The main motivation here is to reduce the amount of retyping required to edit and prepare a document. If a page of text is typed manually, the words are entered on the page in a fixed format. Also, the words themselves are fixed. If a change of format or wording of that text is desired, it is necessary, in most cases, to retype the entire page. With the advent of the computer, the user needs only to enter the words that change or enter a new formatting command—the computer will do the rest.

The program we are presenting is fairly simple and contains a basic set of commands for formatting. Table 1 shows the complete command repertoire of the formatter. It is written in BASIC to allow easier understanding and provide machine independence.

The actual formatter code is implemented in about 70 source lines. Whenever the editor WRITE command is called, the formatter will be automatically invoked. Any formatting commands appearing in the editor buffer will now be executed, and the associated formatting actions will take place.

These formatting commands can be embedded anywhere within the raw text and are surrounded by \ (backslash) symbols so that the program can identify them. The general rules of syntax for each command are given in the formatter command guide (see Table 2).

**See the copyright disclaimer on page 93 of the January 1979 issue. We had, and have, no intention of copping a copyright. —Editors.*

Formatter Usage

Let's take apart a sample editor data set (Example 1) that has been created by the Editor. If we were to execute a WRITE command, the printout of Example 2 would result; the embedded formatter commands are used to control text placement. The commands are not printed.

Line numbers 1-4 contain the letterhead. The upper page spacing (Un) has been defaulted and generates six line feeds at the top of the page. \S2\\T30\ causes two more line feeds and a tab to character position 30, where the text following the TAB command is printed.

When the second \T30\ is encountered, the cursor is already beyond position 30 in the current line. The TAB command automatically generated a break and spaced to position 30 of a new line. This action is repeated for the third \T30\. All commands that generate a break in text do this before their functions occur.

\S0\ in line 2 generates a break only, which results in a line feed/carriage return. This is used to align text even though

\Sn\	Break, space (n) number of lines
\In\	Break, indent (n) number of characters
\Cn\	Break, center next text
\Tn\	Break, tab (n) number of characters
\En\	Break, eject (n) number of pages
\Mn\	Set line spacing by (n)
\Fn\	Set formatting mode
\Un\	Set upper spacing
\Dn\	Set down spacing
\Ln\	Set left margin
\Rn\	Set right margin
\Pn\	Set page length
\Nn\	Set page numbering

Table 1. Formatter commands.

\Sn\: Break and space (n) number of lines. If (n) is defaulted, space one line. If (n = 0), only a break is performed with no spacing.

\In\: Break and indent (n) number of characters. Indenting is performed relative to the left margin. The default value of (n) is ten characters, which is the amount normally used to begin a new paragraph.

\Cn\: Break and center text. \C0\ is used to indicate the start of text to be centered. \C1\ is used to indicate the end of text to be centered. All text within these delimiters will be centered on the next line. The default value of (n) is zero.

\Tn\: Tab (n) number of characters. Tab setting is performed relative to the left margin. If the cursor is already beyond the desired tab position, a new line will be started and the cursor will be positioned at the tab. The default value of (n) is five characters.

\En\: Break and eject (n) number of pages. The default value of (n) is one page.

\Mn\: Set line spacing equal to (n). Spacing remains the same until another line spacing command is reached. The default value of (n) is single spacing.

\Fn\: Set formatting mode on or off. Formatting mode on (n = 1) causes text alignment and justification to be implemented. Formatting mode off (n = 0) outputs the data set as it exists in the editor buffer. In either case, all other formatter commands will be recognized. The default value of (n) is 1.

\Un\: Set upper page spacing equal to (n). This is the spacing between the top of the page and the first line of text. The default value of (n) is six lines.

\Dn\: Set lower page spacing equal to (n). This is the spacing between the last line of text and the bottom of the page. The default value of (n) is four lines.

\Ln\: Set the left margin position equal to (n). The default value of (n) is character position zero.

\Rn\: Set the right margin position equal to (n). The default value of (n) is character position sixty-two.

\Pn\: Set the page length equal to (n). The page length is the spacing between the top and bottom of the page. All page boundaries are based on this length. Page numbering and eject also depend on page length. The default value of (n) is sixty lines.

\Nn\: Set page numbering on or off. Initially, numbering is off (n = 0). Page numbering on causes the page count to be printed at the bottom center of each page.

Table 2. Formatter command guide.

```
 1        \S2\\T30\R.M. LAW\T30\D.C. MITCHELL\T30\ILLINOIS
 2        \S4\KILOBAUD\S0\PETERBOROUGH, NH 03458
 3        \S3\GENTLEMEN
 4        \S1\\F1\
 5        \I\HERE IS AN EXCERPT FROM A POSSIBLE ARTICLE FOR PUBLICATION
 6        IN KILOBAUD.  IT DEALS WITH THE TOPIC OF ARTIFICIAL
 7        INTELLIGENCE
 8        AND THE MANY ADVANCES IN SOFTWARE TECHNOLOGY.
 9        SOME OF THE NEW IDEAS PRESENTED ARE ALREADY GIVING US GREAT
10        HELP IN SEEING HOW THE HUMAN BRAIN OPERATES, AND CONCEPTS SUCH
11        AS 'CONSCIOUSNESS', 'INTUITION', AND 'INTELLIGENCE' ARE
12        ALREADY BEGINNING TO LOSE THEIR MYSTERY--
13        \S3\\L10\\R50\\C0\COMPUTERS AND TOMMORROW\C1\
14        \S2\\I5\DURING THE SUMMER OF 1962, ROBERT W. NEALY, A FORMER
15        CHECKERS CHAMPION OF CONNECTICUT, LOST A GAME OF CHECKERS FOR
16        THE FIRST TIME IN EIGHT YEARS OF PLAY. THE MATCH WAS AGAINST
17        A NEWCOMER IN THE GAME, WHO HAD JUST STARTED LEARNING THE GAME
18        IN 1955, BUT HAD SINCE THEN LEARNED THE SKILL OF THE GAME VERY
19        RAPIDLY.  IT WAS NO DOUBT A BIG CONCERN FOR MR. NEALY TO HAVE
20        LOST THE GAME, BUT IT WAS EVEN MORE CONCERNING THAT HIS
21        CON@UEROR WAS
22        AN IBM 7094 ELECTRONIC COMPUTER.  THE MATCH HAD BEEN WON
23        FAIRLY, THE MACHINE HAD NOT RECEIVED ANY OUTSIDE HELP....
24        \S3\\L\\R\THIS CONCLUDES THE SAMPLE WRITEUP.
25        \S0\\F0\WE LOOK FORWARD TO HEARING FROM YOU,
26        \S2\\T40\R.M. LAW\T40\D.C. MITCHELL
?
```

Example 1.

```
 1        \S2\\T30\R.M. LAW\T30\D.C. MITCHELL\T30\ILLINOIS
 2        \S4\KILOBAUD\S0\PETERBOROUGH, NH 03458
 3        \S3\GENTLEMEN
 4        \S1\\F1\
 5        \I\HERE IS AN EXCERPT FROM A POSSIBLE ARTICLE FOR PUBLICATION
 6        IN KILOBAUD.  IT DEALS WITH THE TOPIC OF ARTIFICIAL
 7        INTELLIGENCE
 8        AND THE MANY ADVANCES IN SOFTWARE TECHNOLOGY.
 9        SOME OF THE NEW IDEAS PRESENTED ARE ALREADY GIVING US GREAT
10        HELP IN SEEING HOW THE HUMAN BRAIN OPERATES, AND CONCEPTS SUCH
11        AS 'CONSCIOUSNESS', 'INTUITION', AND 'INTELLIGENCE' ARE
12        ALREADY BEGINNING TO LOSE THEIR MYSTERY--
13        \S3\\L10\\R50\\C0\COMPUTERS AND TOMMORROW\C1\
14        \S2\\I5\DURING THE SUMMER OF 1962, ROBERT W. NEALY, A FORMER
15        CHECKERS CHAMPION OF CONNECTICUT, LOST A GAME OF CHECKERS FOR
16        THE FIRST TIME IN EIGHT YEARS OF PLAY.  THE MATCH WAS AGAINST
17        A NEWCOMER IN THE GAME, WHO HAD JUST STARTED LEARNING THE GAME
18        IN 1955, BUT HAD SINCE THEN LEARNED THE SKILL OF THE GAME VERY
19        RAPIDLY.  IT WAS NO DOUBT A BIG CONCERN FOR MR. NEALY TO HAVE
20        LOST THE GAME, BUT IT WAS EVEN MORE CONCERNING THAT HIS
21        CON@UEROR WAS
22        AN IBM 7094 ELECTRONIC COMPUTER.  THE MATCH HAD BEEN WON
23        FAIRLY, THE MACHINE HAD NOT RECEIVED ANY OUTSIDE HELP....
24        \S3\\L\\R\THIS CONCLUDES THE SAMPLE WRITEUP.
25        \F0\WE LOOK FORWARD TO HEARING FROM YOU,
26        \S2\\T40\R.M. LAW\T40D.C. MITCHELL
?
```

Example 3.

the formatting mode is on. \F1\ in line 4 is not required because the formatting mode default is to "on." Lines 1-4 could also have been done by turning formatting off (\F0\) and indenting 30 character positions (\I30\) with respect to the left margin.

The text in lines 5-12 (Example 1) was typed without any concern for page structure or appearance. Here, the author is obviously going to rely on the computer to help out in these tasks. The formatted result in the first paragraph of Example 2 shows what alignment and justification will produce in the end product. The text in lines 13-23 (Example 1) has been set off by changing the left and right margins (\L10\\R50\).

Two items of importance are: (1) the text between \C0\ and \C1\, line 13, has been centered and (2) line 14, indent five character positions (\I5\), is performed with respect to the new left margin (\L10\). The remaining text, lines 24-26, returns the margin boundaries to default (\L\\R\) and turns formatting off.

Examples 3 and 4 are basically the same examples just described except for three errors left in the editor data set. The first two errors in line 16 and line 25 are printing-control errors, while line 26 shows an example of a formatter command error.

Line 16: This type of user error may or may not be seen in the formatted paper. The error is the double blanks in the area "PLAY. THE." In this run the formatted line happened to start with " THE." The formatter saw the two blanks and assumed the author was forcing them for printing, thus the printed line (Example 4) shows one indented blank.

Remember, the formatter never removes blanks (or anything) from the raw text. The computer assumes they are there because you want them

```
                                R.M. LAW
                                D.C. MITCHELL
                                ILLINOIS


KILOBAUD
PETERBOROUGH, NH 03458


GENTLEMEN

        HERE IS AN EXCERPT FROM A POSSIBLE ARTICLE FOR
PUBLICATION IN KILOBAUD.  IT DEALS WITH THE TOPIC OF ARTIFICIAL
INTELLIGENCE AND THE MANY ADVANCES IN SOFTWARE TECHNOLOGY.
SOME OF THE NEW IDEAS PRESENTED ARE ALREADY GIVING US GREAT
HELP IN SEEING HOW THE HUMAN BRAIN OPERATES, AND CONCEPTS SUCH
AS 'CONSCIOUSNESS', 'INTUITION', AND 'INTELLIGENCE' ARE
ALREADY BEGINNING TO LOSE THEIR MYSTERY--


                COMPUTERS AND TOMMORROW


     DURING THE SUMMER OF 1962, ROBERT
W. NEALY, A FORMER CHECKERS CHAMPION OF
CONNECTICUT, LOST A GAME OF CHECKERS FOR
THE FIRST TIME IN EIGHT YEARS OF PLAY.
THE MATCH WAS AGAINST A NEWCOMER IN THE
GAME, WHO HAD JUST STARTED LEARNING THE
GAME IN 1955, BUT HAD SINCE THEN LEARNED
THE SKILL OF THE GAME VERY RAPIDLY.  IT
WAS NO DOUBT A BIG CONCERN FOR MR. NEALY
TO HAVE LOST THE GAME, BUT IT WAS EVEN
MORE CONCERNING THAT HIS CON@UEROR WAS
AN IBM 7094 ELECTRONIC COMPUTER.  THE
MATCH HAD BEEN WON FAIRLY, THE MACHINE
HAD NOT RECEIVED ANY OUTSIDE HELP....


THIS CONCLUDES THE SAMPLE WRITEUP.
WE LOOK FORWARD TO HEARING FROM YOU,

                                R.M. LAW
                                D.C. MITCHELL
```

Example 2.

```
                                R.M. LAW
                                D.C. MITCHELL
                                ILLINOIS


KILOBAUD
PETERBOROUGH, NH 03458


GENTLEMEN

        HERE IS AN EXCERPT FROM A POSSIBLE ARTICLE FOR
PUBLICATION IN KILOBAUD.  IT DEALS WITH THE TOPIC OF ARTIFICIAL
INTELLIGENCE AND THE MANY ADVANCES IN SOFTWARE TECHNOLOGY.
SOME OF THE NEW IDEAS PRESENTED ARE ALREADY GIVING US GREAT
HELP IN SEEING HOW THE HUMAN BRAIN OPERATES, AND CONCEPTS SUCH
AS 'CONSCIOUSNESS', 'INTUITION', AND 'INTELLIGENCE' ARE
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                COMPUTERS AND TOMMORROW


     DURING THE SUMMER OF 1962, ROBERT
W. NEALY, A FORMER CHECKERS CHAMPION OF
CONNECTICUT, LOST A  GAME OF CHECKERS FOR
THE  FIRST TIME IN  EIGHT YEARS OF  PLAY.
 THE MATCH  WAS AGAINST A NEWCOMER IN THE
GAME, WHO  HAD  JUST STARTED LEARNING THE
GAME IN 1955,  BUT HAD SINCE THEN LEARNED
THE  SKILL OF  THE GAME VERY RAPIDLY.  IT
WAS NO  DOUBT A BIG CONCERN FOR  MR. NEALY
TO HAVE LOST  THE GAME, BUT  IT  WAS EVEN
MORE  CONCERNING THAT HIS  CON@UEROR  WAS
AN IBM  7094  ELECTRONIC  COMPUTER.  THE
MATCH  HAD  BEEN WON FAIRLY,  THE  MACHINE
HAD NOT RECEIVED ANY OUTSIDE HELP....


THIS CONCLUDES THE SAMPLE WRITEUP. WE LOOK FORWARD TO HEARING FROM YOU,


FORMATTER COMMAND ERROR
 26        \S2\\T40\R.M. LAW\T40D.C. MITCHELL
?
```

Example 4.

FORMATTER COMMAND ERROR

Error in command format, option or delimiter which results in ambiguous interpretation by the formatter. The current line number of the editor data set is printed, and the editor is invoked. The error can be corrected and the WRITE command reentered.

SET CARRIAGE AT TOP OF PAGE AND HIT RETURN

To keep page margins and boundaries aligned, the first page must be properly set before formatting resumes.

ILLEGAL VERTICAL SPACING

The user requested an illegal combination of options, (Un, Dn, Pn and Mn).

ILLEGAL MARGIN VALUES

The user requested an illegal combination of options, (Rn and Ln).

Output messages.

650-699	Write command
3000-3004	Space formatter option
3005-3009	Indent formatter option
3010-3014	Center formatter option
3015-3019	Tab formatter option
3020-3024	Eject formatter option
3025-3029	Line mode formatter option
3030-3034	Alignment & justification formatter option
3035-3039	Upper margin formatter option
3040-3044	Down margin formatter option
3045-3049	Left margin formatter option
3050-3054	Right margin formatter option
3055-3059	Page length formatter option
3060-3064	Page numbering formatter option

Program index.

there.

Line 25: The command \F0\ does not generate a break before turning formatting off. Because the formatter may have been within a partially formatted line when the \Fn\ command was reached, it must fill that line with text before executing the new command. One way to correct this is to break before changing the formatting mode (\S0\\F0\).

Line 26: A delimiter (\) after the second tab 40 was omitted. The error here resulted in the formatting run's stopping and the editor's being invoked current to the line in error. The user now could enter the correction and continue by typing:

```
?C.\T40D.\T40\D
?WRITE
```

Theory

The heart of any formatter, and the most difficult part, is the text alignment and justification algorithms (implemented by the FORMATTING MODE command). These algorithms, when active, are responsible for taking randomly spaced text and aligning it so that lines start and end exactly at the margins. This provides a polished and professional appearance to the resulting document.

The algorithm required to do this consists of two phases. First, the formatter must start taking raw text until it has the maximum number of *whole* words that can fit on a line of the output document. To do this, the editor buffer is viewed as a continuous stream of text, and editor line boundaries are ignored. When the maximum number of words that will fit is obtained, the first phase is complete. The result of this process is called a "raw line."

The next phase is to take the raw line and convert it to a final printed line by applying alignment and justification operations. Alignment refers to margin alignment and ensures that the first word begins at the left margin and the last word ends at the right margin. Justification refers to the task of juggling the remaining words and inserting extra blanks so that the entire line has a controlled appearance with a slight degree of randomness.

The randomness is important in order to produce a polished and natural look. If the algorithm inserted all the extra blanks needed to fill the line in words near the left margin, the entire document would appear more dense or darker on the right side. A similar unnatural appearance will occur if any fixed positioning approach is used. Thus, the way to ensure a natural look is to employ an algorithm with some randomness.

Now for a look at this process in more detail. The alignment and justification algorithm is implemented in two passes, one corresponding to each phase. During the first pass, raw text is pulled from the editor buffer and placed into a line buffer. This continues until a word that cannot be added into the line buffer without overflowing is found.

During this time, two counts, N and B, are formed. N is equal to the number of characters of raw text (including blanks) which were placed in the line buffer. B is the number of blank slots between words. A blank slot is defined as an occurrence of one or more consecutive blank characters. To summarize, the first pass has (1) formed a "rough draft" line of text and (2) performed some statistical measurements about the text itself.

The second pass is responsible for polishing the line and printing it. If there are N characters available for printing a line W characters long, then there

CW	Formatter center mode (0 = center off, 1 = begin center, 2 = end center)
MW	Formatter line mode (1 = single spacing, 2 = double spacing, etc.)
FW	Formatter switch (0 = formatting off, 1 = formatting on)
UW	Formatter upper spacing
DW	Formatter down spacing
LW	Formatter left margin
RW	Formatter right margin
PW	Formatter page length
NW	Formatter page numbering (NW = current page number, 0 = numbering off)
G$	"\"
F$	"SICTEMFUDLRPN" first letter of each formatter command
V	Vertical cursor position
W	Page width (RW – LW + 1)
S	Parameter value of formatter command (= – 1 if user defaults parameter)
F	Attempted number of characters in formatted line
B	Number of blank slots in current formatting line
N	Number of characters in current formatting line
P	Current editor buffer character pointer
C	Current editor line pointer
R	Temporary
FE	= 1 to eject after last page of document
VS	Vertical spacing
HS	Horizontal spacing

Variables.

Command	Default
SPACE	One space
INDENT	Ten characters
CENTER	Centering off
TAB	Five characters
EJECT	One page
LINE SPACING MODE	Single spacing
FORMATTING MODE	Formatting on
UPPER SPACING	Six lines
DOWN SPACING	Four lines
LEFT MARGIN	Character position zero
RIGHT MARGIN	Character position sixty-two
PAGE LENGTH	Sixty lines
PAGE NUMBERING	Numbering off

Program defaults.

Text before formatting: "THIS LOCATION IS NORTH"

RANDOM NUMBER	K	B	F	FORMATTED TEXT
-	-	3	2	
1	1	2	1	|THIS LOCATION |
1	1	1	0	|THIS LOCATION IS |
1	0	0	0	|THIS LOCATION IS NORTH|

Example 5. Formatting example with all random numbers equal to 1.

"Micro-Computer Products to Look Up to"

NorthStar Gazer

Horizon Disk Capacity Keeps Growing

The Horizon is now capable of 720K bytes on-line! The Horizon can connect to four double density 5¼" single-sided disk drives. Each of those drives can access 180K bytes of information. A four drive system accesses 720K bytes!

That's capacity you don't usually find in a microcomputer, but there's even more to come! The North Star disk controller board is designed so that two-sided disk drives may be added as soon as they become available from North Star.

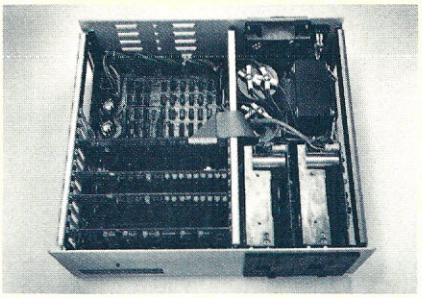
Existing Horizons will accommodate the new two-sided drives so North Star owners can simply add additional drives to up-grade their system. Each two-sided drive will access 360K bytes! That means the maximum on-line disk storage for the Horizon will increase to over 1.4 **million** bytes!

New Cabinet for Disk Drives

North Star additional disk drives are now available with the same high quality wood cover as the Horizon computer! The Additional Drive Cabinet (ADC) is designed to accept either one or two drives for the Horizon or for mounting North Star Micro Disk System drives. Like the Horizon, the ADC is available with either wood or blue metal cover. Included is a new power supply capable of powering one or two drives. The ADC is $129 in kit form. Assembled, with one drive the ADC is $599, with two drives $999.

Pascal Now Available for Horizon

The much-heralded Pascal language is now being offered for use with the North Star Horizon computer. North Star, with the co-operation of the University of California at San Diego, is now delivering a Pascal Program Development system. North Star Pascal is ideally suited for developing large programs because of features such as: long variable names, block-structured control statements, and compilation. North Star Pascal is available on 5¼" diskettes for use with the Horizon or Micro Disk System. North Star Pascal will operate with either the Z80 or 8080 microprocessor.



Inside view of Horizon with processor board, RAM board, disk controller, two drives, and power supply.

Pascal, including documentation, is available in either single or double density versions for $49.

An auxiliary Pascal diskette, containing an 8080/Z80 assembler and some additional Pascal utilities, is available for $29. Complete information is available at your local retail computer store.

First Double Density, Now Double Memory

The new North Star 32K RAM board (RAM-32) has doubled the memory density of the popular Horizon computer. Available either with the Horizon or other S-100 bus computers, the RAM-32 runs at full speed – no wait states – with the 4 MHz Z80A microprocessor (as well as with slower Z80 and 8080 processors). Addressability of the RAM-32 is switch-selectable in four 8K regions.

North Star RAM features like bank-switching and parity checking are standard. The parity checking capability means that the RAM-32 is constantly diagnosing itself. That's a plus for your system. The fact that parity checking is a North Star RAM-32 standard is a plus for your pocketbook! There is no extra charge for this important capability.

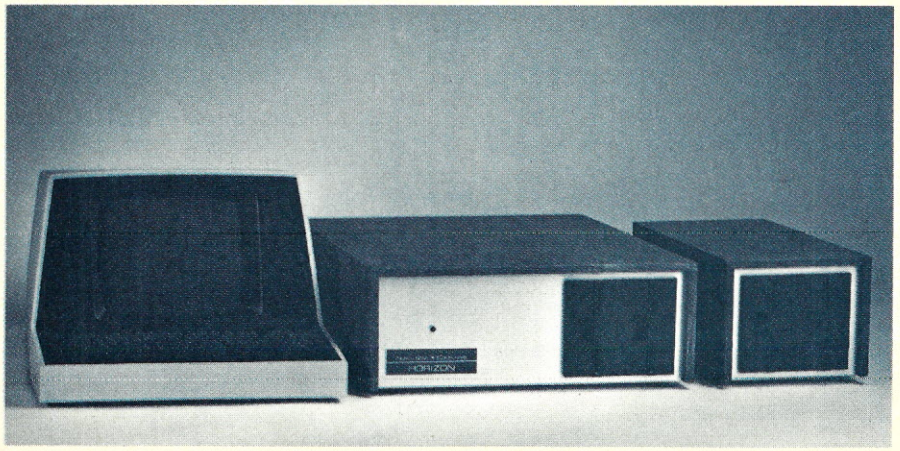
A Horizon with 48K of RAM can be configured by using one North Star 16K RAM board and a RAM-32. Need more memory? 56K can be configured by using two RAM-32 boards with one 8K region switched off.

NORTH STAR MDS, ZPB, FPB FOR OTHER S-100 COMPUTERS

Upgrade your system with these North Star products – available for any S-100 computer: Micro Disk System – a complete 5¼" floppy disk system, Z80 Processor Board, or the Hardware Floating Point Board.

Horizon and RAM board prices are:

	Kit	Assembled
Horizon - 1-16K	$1599	$1899
Horizon - 1-32K	1849	2099
Horizon - 2-32K	2249	2549
RAM-32	599	659
RAM-16	399	459



◀ A typical Horizon configuration: CRT, Horizon computer, Additional Drive Cabinet (ADC).

NorthStar Computers

✓N9

2547 Ninth Street
Berkeley, California 94710
(415) 549-0858

✓ Reader Service—see page 179

Program listing. Includes both the Text Formatter and Editor listings (see "(Con)text Editor," p. 22, Kilobaud No. 21).

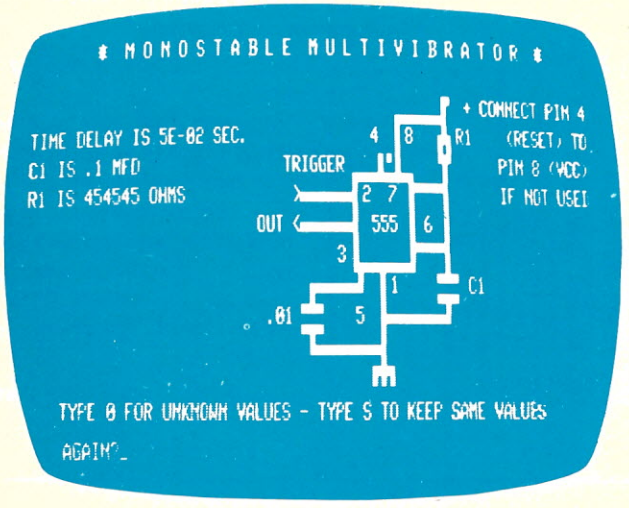
```
1 CLEAR4500:I=0:J=0:K=0:P=0:C=0:B=0:F=0:F=0:U=0:UN=1:S=0:E=0:M=0:L=0:N=0
2 Q=60:DIMF(Q),B(Q),L(Q),L$(Q)
3 B$=" ":A$="A":Z$="Z":X$="0":Y$="9":D$=".":C$="DIPCFONTBRMEWLSKQX"
4 G$="\":F$="SICTMEFUDLRPN"
5 PRINT"EDITOR/FORMATTER"TAB(40)"VERSION 6.0":PRINT:PRINT:PRINT
10 FORI=1TOQ:F(I)=I+1:B(I)=I-1:L(I)=0:L$(I)="":NEXT:F(Q)=0
11 U=0:UN=1:M=0:BY=1
25 L=L(M):P=1:I$=B$:INPUTI$:GOSUB1000:IFR<0THEN40
26 T$=LEFT$(T$,1):FORO=1TO18:IFMID$(C$,O,1)<>T$THENNEXT:GOTO2000
30 ONOGOTO50,100,150,200,250,300,350,400,450,500,550,600,650,700,750,800
31 ONO-16GOTO850,900
40 IFO=5THENB=0:GOTO235
41 GOTO2000
50 S=L:E=L:GOSUB1000:IFR=2THENGOSUB1000:IFR>0THEN2001
51 IFR=0THENS=VAL(T$):E=S:GOSUB1000:IFR=2THENGOSUB1000
52 IFR=0THENE=VAL(T$):GOSUB1000:IFE<STHEN2004
53 IFT$="BY"THENGOSUB1000:BY=VAL(T$):GOTO55
54 IFR=0ORR=1THEN2001
55 IFBY<1E-040RBY>10000!THEN2004
60 B=0:F=0:C=U:IFC=0THEN2006
61 IFC>0ANDL(C)<STHENC=F(C):GOTO61
62 IFC>0ANDL(C)<=ETHENB=C
63 IFC>0ANDL(C)<=ETHENF=C:L(C)=0:C=F(C):GOTO63
70 IFB=0ANDF=0THEN2002
71 M=B(E):IFU=BTHENU=F(F):B(U)=0:GOTO73
72 F(B(B))=F(F):B(F(F))=B(B)
73 F(F)=UN:B(UN)=F:UN=B:M=B(B)
90 IFM=0THENM=U
91 IFO=1THEN2100
92 I=S-BY:GOTO110
100 I=L:GOSUB1000:IFR>1THEN2001
101 IFR=0THENI=VAL(T$):GOSUB1000
102 IFT$="BY"THENGOSUB1000:BY=VAL(T$):GOTO104
103 IFR>0THEN2001
104 IFBY<1E-040RBY>10000!THEN2004
110 B=0:F=U:J=I+BY
111 IFF>0ANDL(F)<JTHENB=F:F=F(F):GOTO111
120 I=VAL(STR$(I+BY)):C=UN:IFO<>12THEN124
121 IFR=0ORL(R)>ETHEN2100
122 I$=L$(R):R=F(R):GOTO125
124 I$="":INPUT">";I$:IFI$=""THEN2100
125 IFUN=0THEN2003
126 UN=F(C):IFF>0ANDI>=L(F)THEN2005
127 IFB=0THENU=C:GOTO129
128 F(B)=C;B(C)=B
129 F(C)=F:B(F)=C:B(UN)=0:L(C)=I:L$(C)=I$:M=C
130 B=C:GOTO120
150 S=L:E=L
151 IFU=0THEN2006
152 GOSUB1000:IFT$="ALL"THENS=0:E=100000!:GOTO160
153 IFR>0THEN2001
154 IFR=0THENS=VAL(T$);E=S:GOSUB1000:IFR=2THENGOSUB1000:IFR>0THEN2001
155 IFR=0THENE=VAL(T$):IFE<STHEN2004
160 C=U:J=0
161 IFC>0ANDL(C)<STHENC=F(C):GOTO161
170 IFC=0ORL(C)>ETHEN180
172 J=1:PRINTL(C)TAB(10)L$(C):M=C:C=F(C):GOTO170
180 IFJ=0THEN2002
182 GOTO25
200 F=0:C=0:B=0:J=LEN(I$):R=J:I=0:IFO=5THENB=J
201 T$=MID$(I$,J,1):IFT$<A$ORT$>Z$THEN207
202 T$=MID$(I$,J,1):IFT$>=A$ANDT$<=Z$THENJ=J-1:IFJ>0THEN202
203 IFJ=0THEN2001
204 T$=RIGHT$(I$,R-J):IFT$="PRALL"THENI=2:GOTO207
205 I=1:IFT$<>"ALL"THEN2001
207 T$=MID$(I$,J,1):IFT$>=X$ANDT$<=Y$THEN2001
208 IFMID$(I$,J,1)=T$THENF=C:C=B:B=J:IFF>0THEN210
209 J=J-1:IFJ>0THEN208
210 S=L:E=L:IFJ=0ORF=0THEN2001
212 S$=MID$(I$,B+1,C-B-1):IFO=5THENE$=S$:E=100000!:GOTO214
213 E$=MID$(I$,C+1,F-C-1)
214 R=9:IFP<BTHENGOSUB1000:IFR>0THEN2001
215 IFR=0THENS=VAL(T$):E=S:IFP<BTHENGOSUB1000
216 IFP<BANDR=2THENGOSUB1000:IFR>1THEN2001
217 IFR=0THENE=VAL(T$)
218 IFP<>BTHEN2001
220 B=0:C=U:IFC=0THEN2006
221 IFC>0ANDL(C)<STHENC=F(C):GOTO221
222 P=1:IFC=0ORL(C)>ETHEN240
223 I$=L$(C):M=C:T$=S$:GOSUB1100:F=P:IFR>0THEN235
224 B=1:L$(C)=MID$(I$,1,P-K-1)+E$:IFI=0THEN230
225 F=P:GOSUB1100:IFR>0THEN230
226 L$(C)=L$(C)+MID$(I$,F,P-F-K)+E$
227 IFI>0THEN225
229 IFO=5THEN2100
230 L$(C)=L$(C)+MID$(I$,F,LEN(I$)-F+1)
231 IFO=5ANDI=0THEN2100
232 IFI=2THENPRINTL(C)TAB(10)L$(C)
235 C=F(C):GOTO222
240 O=0:IFB=0THEN2007
241 IFI<2THEN2100
242 GOTO25
250 GOTO200
300 GOTO50
350 IFU=0THEN2006
351 I=1:GOSUB1000:K=1:IFR<0THEN355
352 IFT$="-"THENI=-1
353 IFR=2THENGOSUB1000:IFR<>0THEN2001
354 K=VAL(T$)
355 J=M:IFI<0THEN370
360 IFJ=0THENPRINT"BOTTOM OF DATA SET REACHED":GOTO2100
361 IFK=0THEN2100
362 J=F(J):K=K-1:IFJ>0THENM=J
363 GOTO360
370 IFJ=0THENPRINT"TOP OF DATA SET REACHED":GOTO2100
371 IFK=0THEN2100
372 J=B(J):K=K-1:IFJ>0THENM=J
373 GOTO370
400 IFU=0THEN2006
401 M=U:GOTO2100
450 F=U:IFU=0THEN2006
451 IFF(F)>0THENF=F(F):GOTO451
452 M=F:GOTO2100
500 J=U:K=1:M=U
501 IFJ=0THEN2100
502 L(J)=K:K=K+1:J=F(J):GOTO501
550 S=L:GOSUB1000:IFR<>0THEN2001
551 I=VAL(T$):GOSUB1000:IFR=2THENGOSUB1000
553 IFR=0THENS=I:I=VAL(T$):GOSUB1000:IFR=2THENGOSUB1000:IFR=2THEN2001
555 E=S:IFR=0THENE=I:I=VAL(T$):GOSUB1000:IFR>1THEN2001
556 IFT$<>"BY"THEN559
557 GOSUB1000:IFR<>0THEN2001
558 BY=VAL(T$):IFBY<1E-040REBY>10000!THEN2004
559 K=0;IFE<STHEN2004
560 J=I:C=0:B=0:F=0:R=U
561 IFR=0THEN2006
562 IFL(R)<=JTHENC=R
563 IFL(R)<STHENR=F(R):GOTO561
564 IFL(R)<=ETHENB=R
565 IFR=0THEN570
566 IFL(R)<=JTHENC=R
567 IFL(R)<=ETHENK=K+1:F=R:R=F(R):GOTO565
568 IFR>0ANDL(R)<=JTHENC=R:R=F(R):GOTO568
570 IFB=0THEN2002
571 IFO=12THENR=B:K=1:GOTO110
572 R=F(C):IFC=0THENR=U
573 IFR=BTHENR=F(F)
574 M=F:IFR>0ANDL(R)<=I+K*BYTHEN2005
575 R=B
576 I=VAL(STR$(I+BY)):L(R)=I:IFR<>FTHENR=F(R):GOTO576
580 IFB(B)=CORF=CTHEN590
582 IFU=BTHENU=F(F)
583 IFF(C)>0THENB(F(C))=B
584 IFF(F)>0THENB(F(F))=B(B)
585 IFB(B)>0THENF(B(B))=F(F)
586 B(B)=C;IFC>0THENF(F)=F(C):F(C)=B:GOTO590
587 F(F)=U:B(U)=F:U=B
```

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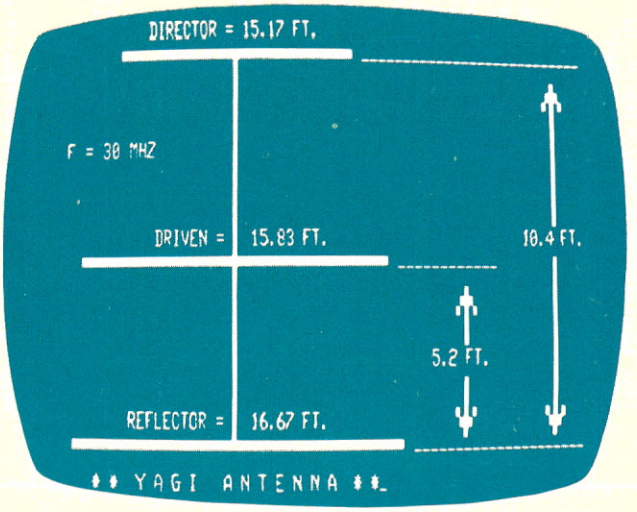
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M-ISR-1

```
590 GOTO2100
600 GOTO550
650 CW=0:MW=1:FW=1:UW=6:DW=4:LW=0:RW=62:PW=60:NW=0:FE=1:S=0:E=100000!
651 E$="":IFU=0THEN2006
652 C=U:B=0:F=0:I=0:N=0:V=1:W=RW-LW+1:GOSUB1000:IFR>0THEN2001
653 IFR=0THENS=VAL(T$):E=S:FE=0:GOSUB1000:IFR=2THENGOSUB1000
654 IFR>0THEN2001
655 IFR=0THENE=VAL(T$):IFE<STHEN2004
656 IFC>0ANDL(C)<STHENC=F(C):GOTO656
657 INPUT"SET CARRIAGE AT TOP OF PAGE AND HIT RETURN";S$
658 O=0:IFC=0ORL(C)>ETHEN690
659 I$=L$(C):M=C:L=LEN(I$):IFL=0THENC=F(C):GOTO658
660 FORP=1TOL:S$=MID$(I$,P,1):IFS$<>G$THEN670
661 S=-1:P=P+1:GOSUB1000:IFR<>1THEN2008
662 S$=LEFT$(T$,1):GOSUB1000:IFR=1THEN2008
663 IFR=0THENS=VAL(T$):GOSUB1000
664 P=P-1:IFT$<>G$THEN2008
665 FORK=1TO13:IFMID$(F$,K,1)<>S$THENNEXT:GOTO2008
666 ONKGOTO3000,3005,3010,3015,3020,3025,3030,3035,3040,3045
667 ONK-10GOTO3050,3055,3060
670 E$=E$+S$:F=F+1:IFFW=0THEN680
671 IFP=LTHENE$=E$+B$:N=F:B=B+1:F=F+1:I=0:O=P:GOTO674
672 IFS$<>B$THENI=1:GOTO674
673 IFI=1THENB=B+1:I=0:N=F-1:O=P
674 IFF<WTHEN680
675 IFB=0THENN=F:O=P
676 E$=LEFT$(E$,N):B=B-1:P=O:F=W-N:GOSUB1200
680 NEXTP:IFFW=0THENGOSUB1200
681 C=F(C):GOTO658
690 FW=0:GOSUB1200:IFV=1ORFE=0THEN25
691 GOSUB1210:IFV>1THEN691
692 GOTO25
700 REM
710 CLOAD*L:CLOAD*F:FORI=1TOQ:T$=""
711 WAIT6,1,1:K=INP(7):IFK<255THENT$=T$+CHR$(K):GOTO711
712 L$(I)=T$:NEXT:U=L(0):UN=F(0):M=U
720 FORI=1TOQ:B(F(I))=I:NEXT:B(U)=0:B(UN)=0:F(0)=0:B(0)=0:L(0)=0:GOTO25
750 REM
760 L(0)=U:CSAVE*L:F(0)=UN:CSAVE*F:FORI=1TOQ:J=LEN(L$(I)):IFJ=0THEN780
770 FORK=1TOJ:R=ASC(MID$(L$(I),K,1))
771 WAIT6,128,128
772 OUT7,R:FORP=1TO5:NEXTP,K
780 WAIT6,128,128
781 OUT7,255:NEXTI:GOTO25
800 INPUT"** DO YOU REALLY WANT TO KILL THE DATA SET (Y/N)";I$
801 IFLEFT$(I$,1)="Y"THEN10
802 GOTO25
850 REM
852 PRINT"NORMAL END":END
900 PRINT"UNUSED ="UN"  USED ="U"  B ="B"  F ="F"  C ="C:PRINT
901 PRINT" I"," F"," B"," L"
902 PRINT:FORI=1TOQ:PRINTI,F(I),B(I),L(I):NEXT:GOTO25
1000 R=-1:J=LEN(I$):IFP>JTHENT$="":RETURN
1001 FORP=PTOJ:IFMID$(I$,P,1)=B$THENNEXT:RETURN
1002 R=2:K=P:T$=MID$(I$,P,1):IFT$>=A$ANDT$<=Z$THEN1010
1003 IFT$>=X$ANDT$<=Y$ORT$=D$THEN1007
1004 P=P+1:RETURN
1007 FORP=PTOJ:T$=MID$(I$,P,1)
1008 IFT$>=X$ANDT$<=Y$ORT$=D$THENR=0:NEXT
1009 T$=MID$(I$,K,P-K):RETURN
1010 FORP=PTOJ:T$=MID$(I$,P,1)
1011 IFT$>=A$ANDT$<=Z$THENR=1:NEXT
1012 T$=MID$(I$,K,P-K):RETURN
1100 K=LEN(T$):FORJ=PTOLEN(I$):IFMID$(I$,J,K)<>T$THENNEXT:R=1:RETURN
1101 IFLEN(I$)=0THENI=0
1102 P=J+K:R=0:RETURN
1200 IFUW+DW+MW>PWTHENM=VS:GOTO2009
1201 IFRW<LWTHENM=HS:GOTO2010
1202 IFLEN(E$)=0THENE$="":N=0:B=0:F=0:I=0:RETURN
1203 IFV=1THENIFUW>0THENFORI=1TOUW:PRINT:NEXT:V=UW+1
1204 PRINTTAB(LW);:IFFW=0THENPRINTE$;:GOTO1209
1205 J=-1:FORI=1TOLEN(E$):S$=MID$(E$,I,1):IFS$<>B$THENJ=I:GOTO1207
1206 IFJ=1ANDB>0THENK=INT(F/B+RND(1)):PRINTSPC(K);:B=B-1:F=F-K:J=0
1207 PRINTS$;:NEXT
1209 E$="":N=0:B=0:F=0:I=0
1210 PRINT:V=V+1:IFPW-DW-V<MW-1THEN1213
1211 IFMW=1THENRETURN
1212 FORI=1TOMW-1:PRINT:NEXT:V=V+MW-1:RETURN
1213 IFV<PW-DW+1THENFORI=VTOPW-DW:PRINT:NEXT:V=PW-DW
1214 IFNW>0THENPRINTTAB(LW+W/2);NW:NW=NW+1:V=V+1
1215 IFV<PWTHENFORI=VTOPW:PRINT:NEXT
1216 PRINT:V=1:RETURN
2000 PRINT"NOT A COMMAND":GOTO25
2001 PRINT"SYNTAX ERROR":GOTO25
2002 PRINT"ILLEGAL LINE NUMBER":GOTO25
2003 PRINT"EDITOR BUFFER FULL":GOTO2100
2004 PRINT"PARAMETER VALUE ERROR":GOTO25
2005 PRINT"NOT ENOUGH SPACE TO INSERT":GOTO2100
2006 PRINT"THE DATA SET IS EMPTY":GOTO25
2007 PRINT"TEXT COULD NOT BE FOUND":GOTO2100
2008 PRINT"FORMATTER COMMAND ERROR":GOTO2100
2009 PRINT"ILLEGAL VERTICAL SPACING":GOTO2100
2010 PRINT"ILLEGAL MARGIN VALUES":GOTO2100
2100 IFM=0THEN2006
2102 PRINTL(M)TAB(10)L$(M):GOTO25
3000 R=FW:FW=0:GOSUB1200:FW=R:S=ABS(S):IFS=0THEN680
3001 J=PW-DW-V:K=S*MW:IFK>JTHENK=J
3002 FORJ=1TOK:GOSUB1210:NEXT:GOTO680
3005 R=FW:FW=0:GOSUB1200:FW=R:IFS<0THENS=10
3006 IFS>WTHEN2008
3007 FORJ=1TOS:E$=B$+E$:NEXT:F=F+S:N=F:GOTO680
3010 S=ABS(S):IF(S>0ANDCW=0)OR(S<1ANDCW=1)OR(S>0ANDCW=2)THEN2008
3011 CW=S+1:IFCW=1THEN3014
3012 K=(W-LEN(E$))/2:IFK<=0THEN3014
3013 FORJ=1TOK:E$=B$+E$:F=F+K:NEXTJ
3014 R=FW:FW=0:GOSUB1200:FW=R:GOTO680
3015 IFS<0THENS=10
3016 IFS>WTHEN2008
3017 J=S-LEN(E$)-1:IFJ<0THENR=FW;FW=0;GOSUBJ200;FW=R;J=S-1
3018 IFJ>0THENFORK=1TOJ:E$=E$+B$:NEXT:F=F+J:N=F:IFI=1THENO=O+1
3019 GOTO680
3020 MW=ABS(S):VS=C:IFMW<1THEN2008
3021 GOTO680
3025 S=ABS(S):IFS<1THEN2008
3026 R=FW:FW=0;GOSUB1200:FW=R:FORJ=1TOS
3027 GOSUBJ210:IFV>1THEN3027
3028 NEXTJ:FW=R:GOTO680
3030 FW=ABS(S):IFFW>1THEN2008
3031 GOTO680
3035 IFS<0THENS=6
3036 UW=S:VS=C:GOTO680
3040 IFS<0THENS=4
3041 DW=S:VS=C:GOTO680
3045 IFS<0THENS=0
3046 LW=S:W=RW-LW+1:HS=C:GOTO680
3050 IFS<0THENS=62
3051 RW=S:W=RW-LW+1:HS=C:GOTO680
3055 IFS<0THENS=60
3056 PW=S:VS=C:GOTO680
3060 NW=-S*(S>0):GOTO680
```

are F = W − N spaces necessary to pad the line. Consequently, we have B slots to insert F spaces.

Here is the tricky part. There must be randomness in placing these blanks for a natural effect. Yet the algorithm cannot be totally random or there would be no guarantee that any or all blanks would be placed.

To overcome these conflicting requirements, the algorithm contains feedback to vary the degree of randomness in the process. The underlying equation is Equation 1 below:

K = INT(F/B + RND(1))

and can best be illustrated in Example 5.

Assume that the raw line "THIS LOCATION IS NORTH" is to be printed and that F = 2 extra spaces must be added in order to fill out the line to the margins. Also observe that there are B = 3 blank slots in the text itself. The printing algorithm is:

1. Print a word and blank

Text before formatting: "THIS LOCATION IS NORTH"

RANDOM NUMBER	K	B	F	FORMATTED TEXT
-	-	3	2	
0	0	2	2	|THIS LOCATION |
0	1	1	1	|THIS LOCATION IS |
0	1	0	0	|THIS LOCATION IS NORTH|

Example 6. Formatting example with all random numbers equal to 0.

slot

2. Evaluate Equation 1
   a. if K = 0, go to step 3
   b. if K = 1, print an extra blank and subtract 1 from F
3. Subtract 1 from B
4. Repeat steps 1-3 until end of raw line is reached

Example 5 shows how this algorithm works if the random numbers all turned up = 1. Note that the added blanks are all inserted in the left side of the line. Conversely, if all the random numbers turned up = 0, all blanks would be inserted in the right side of the line, as shown in Example 6.

In reality, the number will vary in a truly random fashion anywhere between 0 and 1 and thus cause the blanks to be inserted randomly throughout the line. Careful inspection of Equation 1 will show that the equation actually modifies the strength of the randomness in a way that guarantees all blanks will be placed (F = 0) by the time the printing reaches the right margin.

Conclusion

The Text Formatter has become a recognized tool in many day-to-day problems involving written communications. You can keep several "canned" data sets to produce letters, sales forms, purchase orders and other common forms on tape. Then you merely load one, add the specific text and run.

For example, you can make a data set with formatting commands to produce a letter with return address, greeting and closing. Every time you need a letter, you just insert the message text and run. If you also have a "canned" message, then all you need to do is insert a person's name in order to produce an entire letter.

Whatever your application and written communication needs, we think you will find this both a useful and interesting piece of software. ■

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KIMCTR

This KIM-1 frequency counter/timer can be used with any micro with comparable features.

Clement S. Pepper
3270-96 Caminito East Bluff
La Jolla CA 92037

A low-cost frequency counter is readily constructed from an LSI counter IC and your KIM-1. KIM controls the counter, generates the one-second time base and displays the count.

If you don't have a KIM-1, read on anyway . . . the program is adaptable to any microcomputer on-a-board having comparable features. The prime requirements are addressable I/O ports and a hexadecimal display that can be controlled by your program.

The LS7030,[1] an 8-decade multiplexed MOS up counter, performs the counting. In addition to the counter and KIM, the design includes an input stage with threshold adjustment. I have also added circuitry for time mode measurement of both positive and negative pulses, with the widths displayed in microseconds for up to one second. I/O buffers are also provided—both to match the ports to the counter and to give protection, just in case. . . . The KIM-1 supply provides dc power.

1. The LS7030 is manufactured by LSI Computer Systems, Inc., 1235 Walt Whitman Road, Melville NY 11746. Telephone: (516) 271-0400. Query the manufacturer for distributors in your area. The device can be purchased from Mesa Engineering Sales, 7525 Convoy Court, San Diego CA 92111. Telephone: (714) 278-8021.

Features

The frequency mode provides for two ranges: 1 Hz to 1 MHz with 1 Hz resolution or 10 Hz to 10 MHz with 10 Hz resolution. The LS7030 is specified to 5 MHz so the full x10 range may not be realized. If desired, the input can include pre-scaling, which I have not included. The time mode provides a measure of pulse width; positive- or negative-going pulses are switch selectable. The input may be a single pulse or a wave train. The sum of the positive and negative widths in a uniform train is the period. Resolution is 1 usec.

KIM provides full control of the counter via four I/O ports. Six digits of frequency or time are displayed on KIM's seven-segment readout. The display program is also the one-second time base for the frequency measurement.

Fig. 1 is a function diagram of the counter/timer. The basic functions are a high-impedance input stage with an adjustable threshold for sensitivity control, capture circuitry for the pulse width measurement, the LS7030 counter and KIM-1.

The LS7030 Counter IC

Fig. 2 is the internal circuitry of the counter. Key features of the LS7030 include dc to 5 MHz counting, multiplexed BCD and seven-segment outputs, single-power supply operation at 4.75 V dc to 15 V dc, high noise immunity, counter input latches and leading zero blanking.

The count input ripples through eight BCD counter stages. Each stage is provided with a 4-bit latch. Data stored in the latches is connected to the internal BCD bus by multiplexed switching. The switching sequence is controlled by a scan counter and decoder. The BCD lines are internally decoded to provide seven-segment outputs. Blanking for leading zero suppression is implemented internally.

All decades are reset to zero when $\overline{\text{RESET}}$ is brought low for a minimum of 4 usec. Contents of the counter are transferred to the latches when the $\overline{\text{LOAD}}$ signal is brought low for a minimum of 4 usec and kept low until a minimum of 17 usec has elapsed from the negative edge of the preceding count pulse. Raising the $\overline{\text{LOAD}}$ signal stores the counter data in the latches.

The counter scans from the most significant digit (MSD) to the least significant digit (LSD). When SCAN RESET is brought high, the scan counter is forced to the MSD state. The scan counter decrements one count on each negative transition of the SCAN INPUT.

Leading zero blanking is employed. At the start of each MSD-to-LSD scan, the seven-segment outputs are held low until a nonzero digit appears on the BCD bus. The display un-

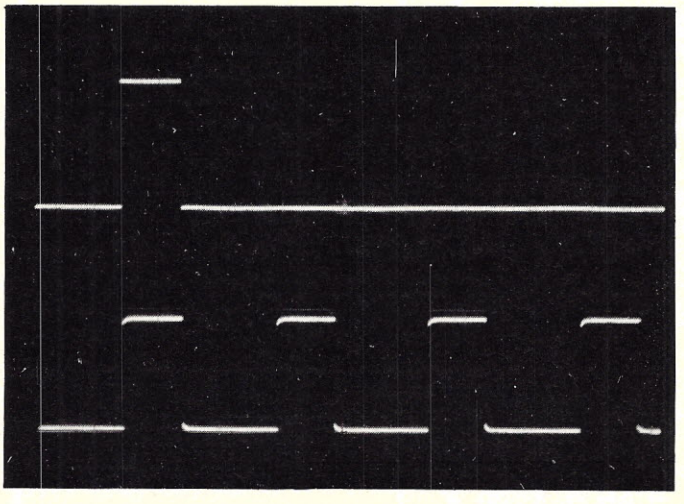


Photo 1. The first pulse of the train displayed in the lower trace has been detected and is displayed in the upper trace.

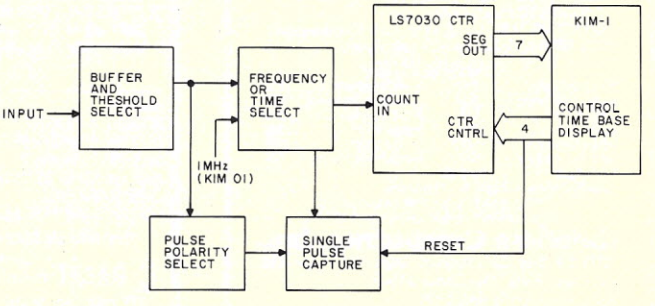


Fig. 1. KIMCTR function diagram.

blanks on the LSD; a zero is displayed when there is no counter input. A comment: In this program the zero is displayed on the x1 range; the entire display is blank on the x10.

All inputs are TTL compatible with +5 V operation. Outputs are CMOS compatible.

Counter Design

The complete circuitry for the counter/timer is shown in Fig. 3. The signal connects to the non-inverting input of an LM339 comparator. Input threshold is controlled by the setting of R4. The values shown yield a threshold of 0 to +2 volts. Other values may be chosen to extend the range if desired. In the frequency mode the signal is conducted through gates U1A and U1C to buffer U6A. The buffer is necessary because all the front-end circuitry operates from +12 V dc, with the counter and buffer at +5 V dc.

If frequency counting is all you need, ICs U1, U2, U3 and U4 will be omitted, along with comparators A1B, A1C and the switching.

The blanking output to PB0 shown is not used. Initially I thought it would be needed. PB5 and PB7 are shown grounded just to keep them from floating; they have no function.

Timer Circuitry

In the time mode a single pulse is plucked from the incoming train to enable gate U1B. A second input to this gate is the 1 MHz clock from KIM. This signal is counted for the duration of the pulse high time; thus the width is displayed in usec.

Now let's back up to see how the gating pulse is selected. Observe that the counter reset pulse is brought around to comparator A1C. This effects a translation from 5 volt logic to 12 volt. The trailing edge of the counter reset from KIM clocks the "D" flip-flop U2A. In so doing it places a "1" at the D input of U2B.

The next positive-going transition at pin 11 of U2B will set the Q output and enable gate U1B. U2A is reset at this time also. With the polarity switch in the "POS" position (as shown), this is the leading edge of an incoming pulse. EX-OR gate U4B is an inverter. The trailing edge of the pulse clocks U3A, which resets U2B, thereby inhibiting the gate and also resetting U3A. The operation of this circuit ensures that one complete pulse, and one pulse only, enables U1B for each counting cycle.

You can see the action in the scope traces in Photo 1. The lower trace is the incoming train; the upper shows that the first trace following reset has been captured.

Single pulse inputs will be accurately timed provided they occur within the one-second counting interval. With S2 in the "NEG" position, the negative portion of the wave is timed. If the pulse train is uniform, the sum of the two times is the period for one complete cycle.

The pulse width displayed corresponds to true width only for rectangular waveform inputs. For other waveforms the width measured is dependent on the waveshape and the threshold setting because of comparator squaring.

With the threshold at zero the displayed width is that of the entire positive or negative portion of the wave. This is illustrated in the scope traces in Photos 2-4. In Photo 2 the threshold is at zero; the comparator output is very nearly a square wave. The input is only 50 mV (RMS), which is about the ultimate sensitivity.

Increasing the input by a factor of 10 (Photo 3) with the

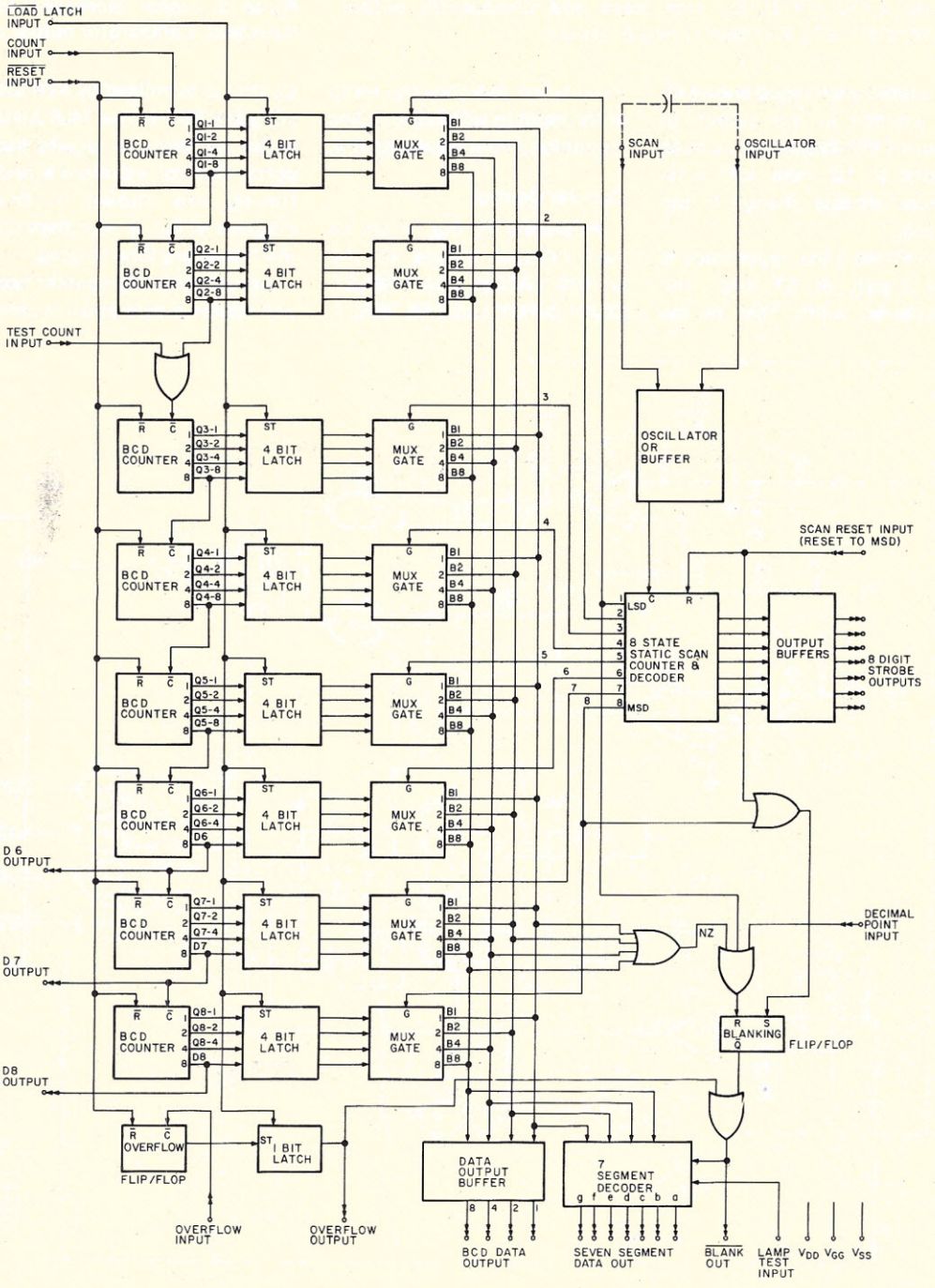


Fig. 2. Internal circuitry of the LS7030 counter. This device is ideally suited for microcomputer control.

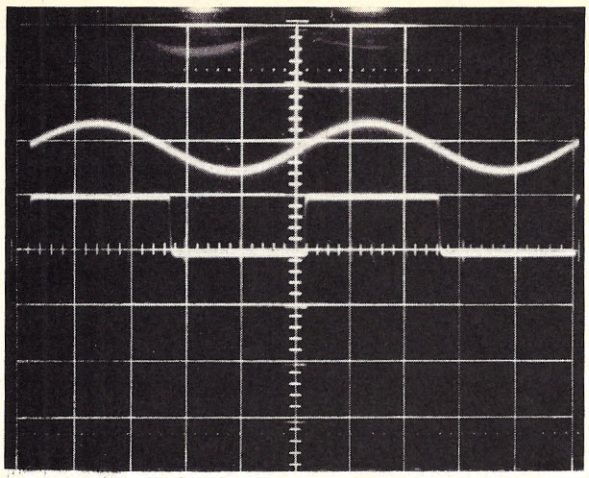


Photo 2. 50 mV (RMS) sine wave and comparator output. Threshold is at 0 V; output is nearly square.

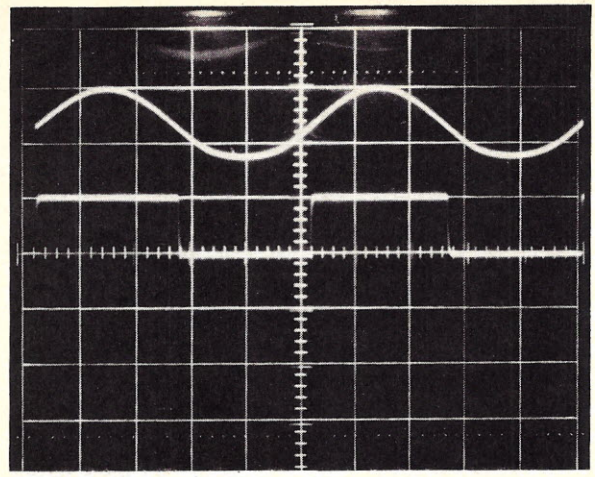


Photo 3. Signal increased to 500 mV (RMS); no change in threshold. Comparator output unchanged.

threshold unchanged shows little change in the output. In Photo 4 the threshold has been upped to 1.2 volts with a resulting drastic change in the output.

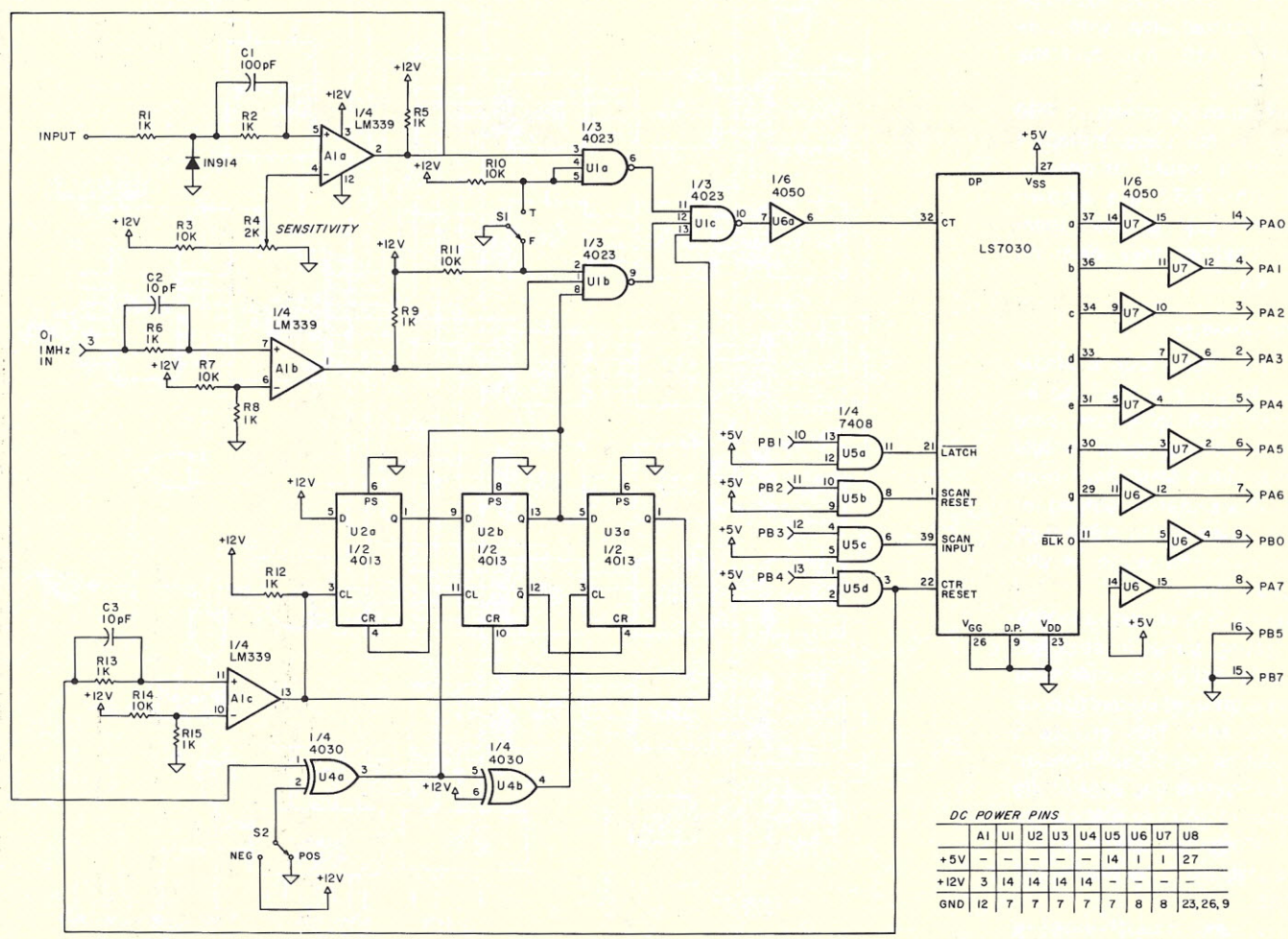
In Photo 5 the upper trace is the input, at 87 kHz. The measured width, that of the lower trace, matches the width of the input to within the 1 usec resolution of the measurement.

Counter Control

Reference to Fig. 3 shows four control inputs to the LS7030: LATCH, SCAN RESET, SCAN INPUT and CTR RESET. Control is exercised by KIM via I/O ports PB1-4. The 7408 AND gates are there to isolate the ports. Control waveforms and timing are shown in the diagram of Fig. 4. Numbers on the traces are time in usec.

Assume that the counter has accumulated data and it is time for KIM to take a collection. The initial step is to store the counter data in the latches and to reset the scan to the MSD. These two operations are performed simultaneously. Eighteen usec were allocated to assure a valid data store.

The SCAN INPUT is next



DC POWER PINS

	A1	U1	U2	U3	U4	U5	U6	U7	U8
+5V	–	–	–	–	–	14	1	1	27
+12V	3	14	14	14	14	–	–	–	–
GND	12	7	7	7	7	7	8	8	23, 26, 9

Fig. 3. Complete circuit diagram of the frequency counter/timer.

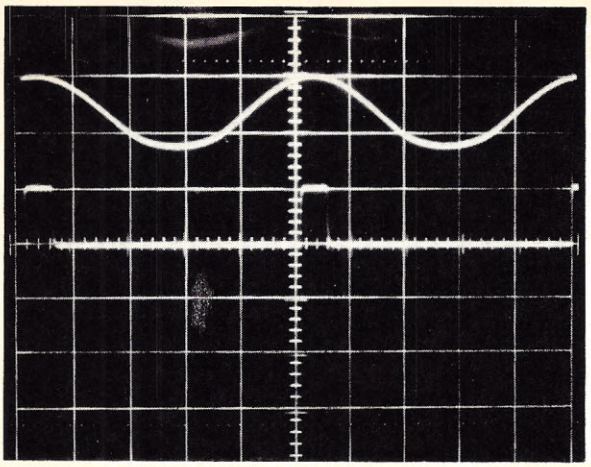


Photo 4. Threshold increase to 1.2 V narrows output pulse. Period is still the sum of positive and negative portions of output.

decremented to digit 7. Decrement occurs on the negative edge at 28 usec. This diagram is for the x1 range, decade 7 is not read and a second decrement is made. Twenty-one usec are absorbed to read and store the data from decade 6. The operation repeats until decade 1 has been read and stored. At 206 usec the counter is reset, and 12 usec later counting is resumed for the next update.

A flowchart for the control routine, CCNTRO, is provided in Fig. 5. The program is listed in Program A. Fig. 6 shows the sequence diagram and coding tables that I used to write the I/O instructions. I am not going into any detail on these as they are self-explanatory from the preceding descriptions after a bit of study. However, should you have any difficulty with these or any part of the system, send me a query with an SASE and I'll do my best to provide an answer.

Display and Timing

Subroutine DISPCT (Fig. 7) generates the six-digit display. The program has two delay loops (1 and 3) adjusted to yield the required one-second time base.

I suppose I could have utilized KIM's SCANDS routine, but I preferred to develop my own. It is a routine I use, with variations, for other things I also do with KIM.

The seven-segment data is read out by port A I/O during the CCNTRO routine and stored in locations 1781-86. The digit select codes are stored in locations 1787-8C; be sure to enter these with the program. Port A segment coding is illustrated in Fig. 8. The listing for DISPCT is provided in Program B.

Construction

I assembled all the circuitry on pegboard; the parts layout is

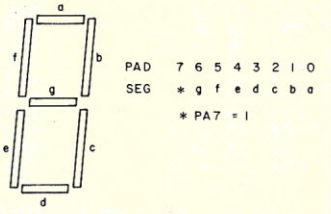


Fig. 8. Seven-segment display coding for Port A. PA7 is held high.

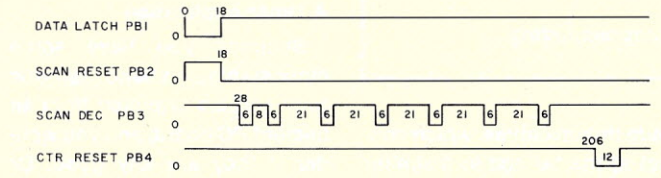
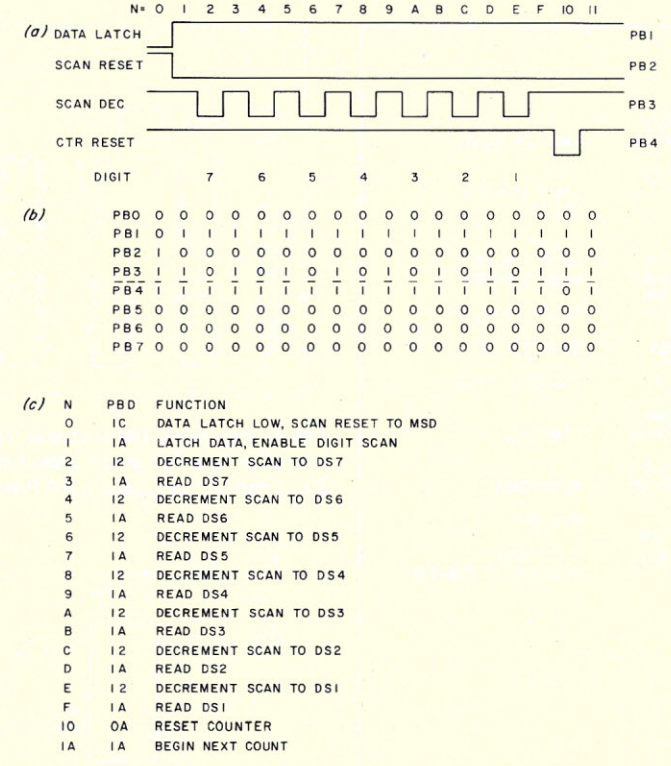


Fig. 4. KIMCTR control timing for x1 measurements. Numbers are time in usec.



(c)

N	PBD	FUNCTION
0	1C	DATA LATCH LOW, SCAN RESET TO MSD
1	1A	LATCH DATA, ENABLE DIGIT SCAN
2	12	DECREMENT SCAN TO DS7
3	1A	READ DS7
4	12	DECREMENT SCAN TO DS6
5	1A	READ DS6
6	12	DECREMENT SCAN TO DS5
7	1A	READ DS5
8	12	DECREMENT SCAN TO DS4
9	1A	READ DS4
A	12	DECREMENT SCAN TO DS3
B	1A	READ DS3
C	12	DECREMENT SCAN TO DS2
D	1A	READ DS2
E	12	DECREMENT SCAN TO DS1
F	1A	READ DS1
10	0A	RESET COUNTER
1A	1A	BEGIN NEXT COUNT

Fig. 6. (a) Sequence diagram. (b) Binary tabulation. (c) Code assignment and functions. This is the format I employ to assure true and complete I/O coding.

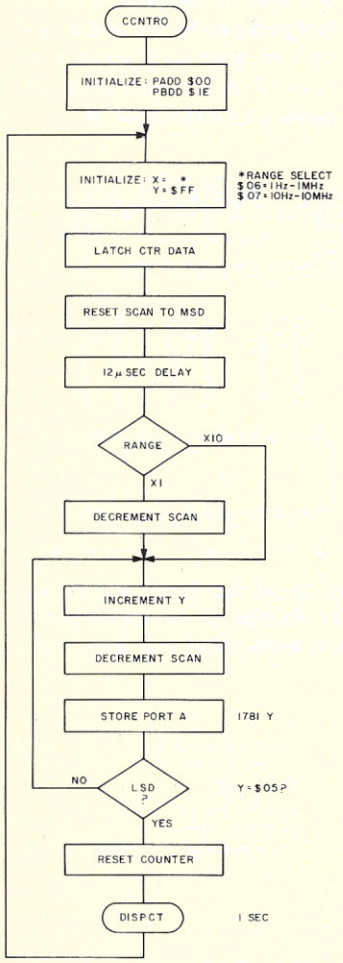


Fig. 5. CCNTRO flowchart.

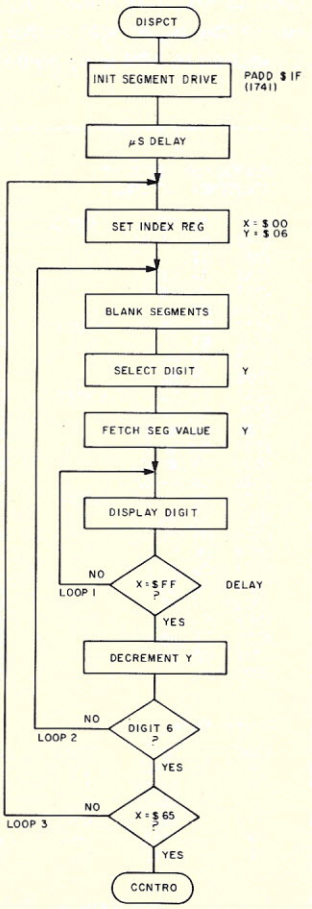


Fig. 7. DISPCT flowchart.

PROGRAM: KIMCTR
ROUTINE: CCNTRO

```
0300  A9 00     INIT    LDA #$00
0302  8D 01 17           STA PADD     PORT A DIR
0305  A9 1E              LDA #$1E
0307  8D 03 17           STA PBDD     PORT B DIR
030A  A2 06     BEGIN   LDX #$06     $06=X1, $07=X10
030C  A0 FF              LDY #$FF
030E  A9 1C              LDA #$1C
0310  8D 02 17           STA PBD      LATCH LOW; SCAN RESET
0313  EA                 NOP          DELAY
0314  EA                 NOP
0315  EA                 NOP
0316  EA                 NOP
0317  EA                 NOP
0318  EA                 NOP
0319  A9 1A              LDA #$1A
031B  8D 02 17           STA PBD      LATCH DATA
031E  E0 07              CPX $07      X10 SELECT
0320  F0 0A              BEQ LOOP1
0322  A9 12              LDA #$12
0324  8D 02 17           STA PBD
0327  A9 1A              LDA #$1A
0329  8D 02 17           STA PBD
032C  C8        LOOP1   INY          BEGIN SCAN AND READ
032D  A9 12              LDA #$12
032F  8D 02 17           STA PBD
0332  A9 1A              LDA #$1A
0334  8D 02 17           STA PBD
0337  AD 00 17           LDA PAD
033A  99 81 17           STA Y        STORE SEG CODE
033D  C0 05              CPY $05
033F  D0 EB              BNE LOOP1    NEXT DECADE
0341  A9 0A              LDA #$0A
0343  8D 02 17           STA PBD      RESET COUNTER
0346  EA                 NOP          DELAY
0347  EA                 NOP
0348  EA                 NOP
0349  A9 1A              LDA #$1A
034B  8D 02 17           STA PBD      RESUME COUNT
034E  20 A0 17           JSR DISPCT   DISPLAY COUNT
0351  4C 0A 03           JMP BEGIN
```

Program A. CCNTRO program listing.

shown in Fig. 9. For connection to KIM, I hacksawed an AP Products #248-L terminal strip, seen in the upper right corner. Connection to KIM is by home-made ribbon cables, which connect at the far end to a similar strip. I brought out all of my KIM circuits to terminal strips for ready access when needed.

PROGRAM: KIMCTR.
ROUTINE: DISPCT.

```
17A0  A9 7F     DISPLA  LDA #$7F
17A2  8D 41 17          STA PADD     KIM'S DISPLAY
17A5  D8                CLD
17A6  A9 FF             LDA #$FF
17A8  85 10             STA          LOOP 3 INDEX
17AA  EA                NOP          DELAY
17AB  E6 10     LOOP3   INC
17AD  EA                NOP          DELAY
17AE  A2 00             LDX #$00     LOOP 1 INDEX
17B0  A0 06             LDY #$06     LOOP 2 INDEX
17B2  A9 80     LOOP2   LDA #$80
17B4  8D 40 17          STA SAD      BLANK DISPLAY
17B7  B9 86 17          LDA Y
17BA  8D 42 17          STA SBD      DIGIT STORE
17BD  B9 80 17          LDA Y
17C0  8D 40 17          STA SAD      SEGMENT STORE
17C3  E8        LOOP1   INX
17C4  E0 F6             CPX #$F6
17C6  D0 FB             BNE LOOP1    TIME DELAY
17C8  88                DEY
17C9  C0 00             CPY #$00
17CB  D0 E5             BNE LOOP2    NEXT DIGIT
17CD  A6 10             LDX
17CF  EA                NOP          FILLER
17D0  E0 5B             CPX #$5B
17D2  D0 D7             BNE LOOP3    TIME DELAY
17D4  60                RTS          RETURN TO CONTRO
```

Display Data

DIGIT	LOC	CODE	LOC
6	1786	13	178C
5	1785	11	178B
4	1784	0F	178A
3	1783	0D	1789
2	1782	0B	1788
1	1781	09	1787

Program B. DISPCT program listing.

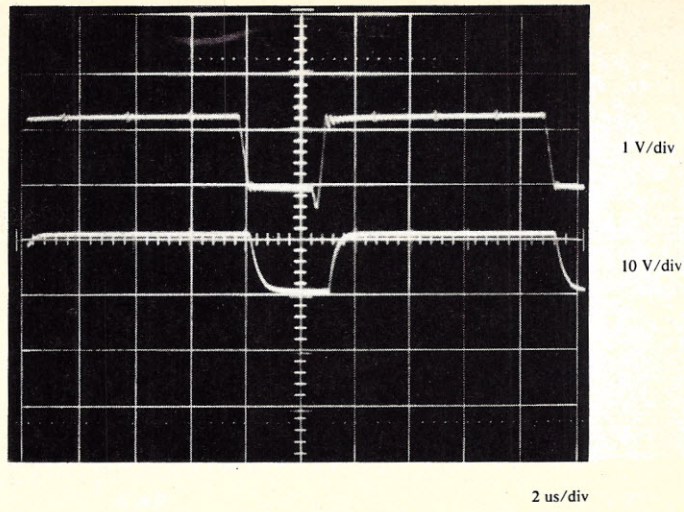


Photo 5. Rectangular input (upper trace) is reproduced in comparator output.

Thus, with the program stored on cassette tape, it takes but a few minutes to have my KIMCTR perking.

A Timer Application

Suppose you have some monostables on hand, perhaps from surplus or pulled from an ancient PC board, and you wonder if they are any good. Or perhaps you have a critical timing requirement and want to adjust the output pulse just so. These are accomplished quickly and easily with the setup illustrated in Fig. 10, where a 74121 is undergoing just such a test. The "B" input is triggered by the rising edge of the reset and the pulse width read out on KIM.

This project is inexpensive and easy to complete. With the foregoing materials and a little time on your part, you'll soon have a micro-controlled frequency counter/timer. ■

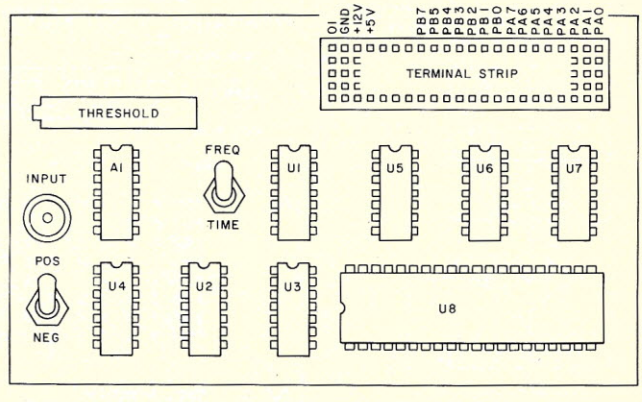


Fig. 9. Pegboard parts layout. I use Circuit Stik Quik Circuits copper stick-ons for parts attachment. Ribbon cable terminated in 8-pin connector plugs in AP Products terminal strip in upper right.

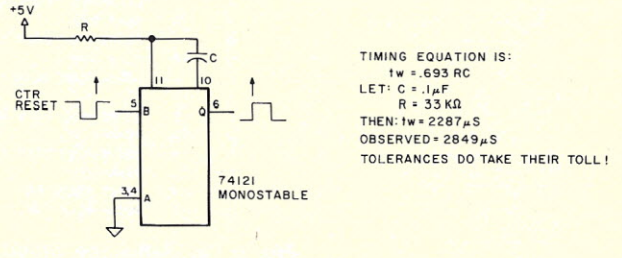
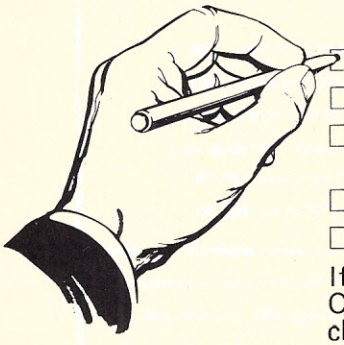


Fig. 10. KIMCTR provides an accurate indication of monostable pulse width.

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Upgrading policy

Any version of The Electric Pencil may be upgraded at any time by simply returning the *original* disk or cassette and the price difference between versions, plus $15 to Michael Shrayer Software. Only the originally purchased cassette or diskette will be accepted for upgrading under this policy.

Have we got a version for you?

The Electric Pencil II operates with any 8080/Z80 based microcomputer that supports a CP/M disk system and uses an Imsai VIO, Processor Tech. VDM-1, Polymorphic VTI, Solid State Music VB-1B or Vector Graphic video interface. REX versions also available. Specify when using CP/M that has been modified for Micropolis or North Star disk systems as follows: for North star add suffix A to version number; for Micropolis add suffix B, e.g., SS-IIA, DV-IIB.

Vers.	Video	Printer	Price
SS-II	SOL	TTY or similar	$225.
SP-II	VTI	TTY or similar	225.
SV-II	VDM	TTY or similar	225.
SR-II	REX	TTY or similar	250.
SI-II	VIO	TTY or similar	250.
DS-II	SOL	Diablo 1610/20	275.
DP-II	VTI	Diablo 1610/20	275.
DV-II	VDM	Diablo 1610/20	275.
DR-II	REX	Diablo 1610/20	300.
DI-II	VIO	Diablo 1610/20	300.
NS-II	SOL	NEC Spinwriter	275.
NP-II	VTI	NEC Spinwriter	275.
NV-II	VDM	NEC Spinwriter	275.
NR-II	REX	NEC Spinwriter	300.
NI-II	VIO	NEC Spinwriter	300.
SSH	SOL	Helios/TTY	250.
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Version	Storage	Price
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TRD	Disk	$150.

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Reader Service—see page 179

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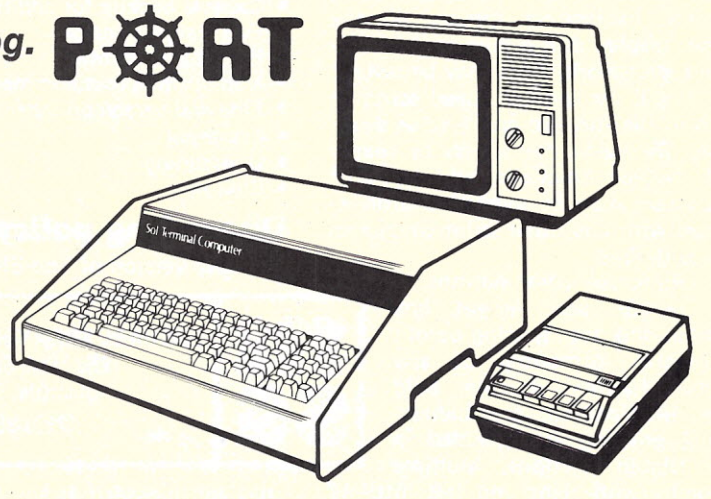
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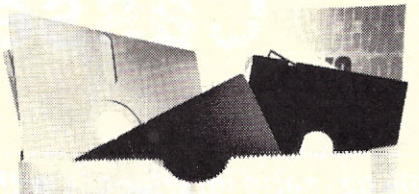
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Super Standard/High-Speed Cassette Interface

A reliable cassette interface is without doubt an extremely convenient addition to a simple development system. This particular inexpensive design features two baud rates.

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The computer hobbyist has a real need for a mass-storage device such as a cassette tape recorder. The need for and usefulness of this kind of storage device has been covered in many articles and in many magazines.

While the need exists and the applicability of it is real, many hobbyists still do not have a cassette tape recorder as an input-output (I/O) device on their computer systems. The reasons for this are: (1) the cost of commercially available devices is too high; (2) many hobbyists prefer to build their own hardware; (3) of all the articles published to date, none has combined both a 300 baud Kansas City Standard (KCS) and a high-speed option in one circuit.

The KCS has proven to be a good and reliable exchange standard and, even if slow, it has wide acceptance and use. Therefore, it will continue in use for many years. But it alone is too slow to serve a hobbyist's own personal system needs. The circuits presented in the past have been either slow 300 baud KCS or high-speed types for which there is no standard.

For both of these cases the circuits have been not only more complicated than necessary, but also too difficult to use. The circuit design of this article is not a solution to all problems, but it does fill the need for a one-circuit KCS and high-speed tape I/O that is easy to use and to construct by any hobbyist.

Circuit Features

This cassette tape recorder interface circuit has the following features: It is low cost (less than $10 for parts) and uses only common 7400 series ICs that are easy to obtain. It operates at both 300 baud and 1200 baud KCS with just the flip of a data rate select switch. No adjustments are required when changing data rates, and after initial setup no operating adjustments are required for normal use.

The circuit uses only a +5 volt power supply. It gives essentially error-free operation even with a low-cost cassette tape recorder. It has a simple three-wire connection to the computer and is easy to use after it is installed.

The overall diagram of my system (see Fig. 1) illustrates how easy it is to connect into a microcomputer system. The circled numbers on the diagram correspond to the system connections of the tape interface circuit logic diagrams.

The American Microsystems, Inc. (AMI), Proto EVK 6800 microprocessor-based development board, augmented by a Davis Labs 16K RAM board and a completely home-brew TV terminal (TVT) interface, form the basis of my system. The TVT enclosure houses the keyboard, TVT logic board and this cassette interface board. The data in and data out lines are RS-232; all others are TTL. The data and X16 clock for the cas-

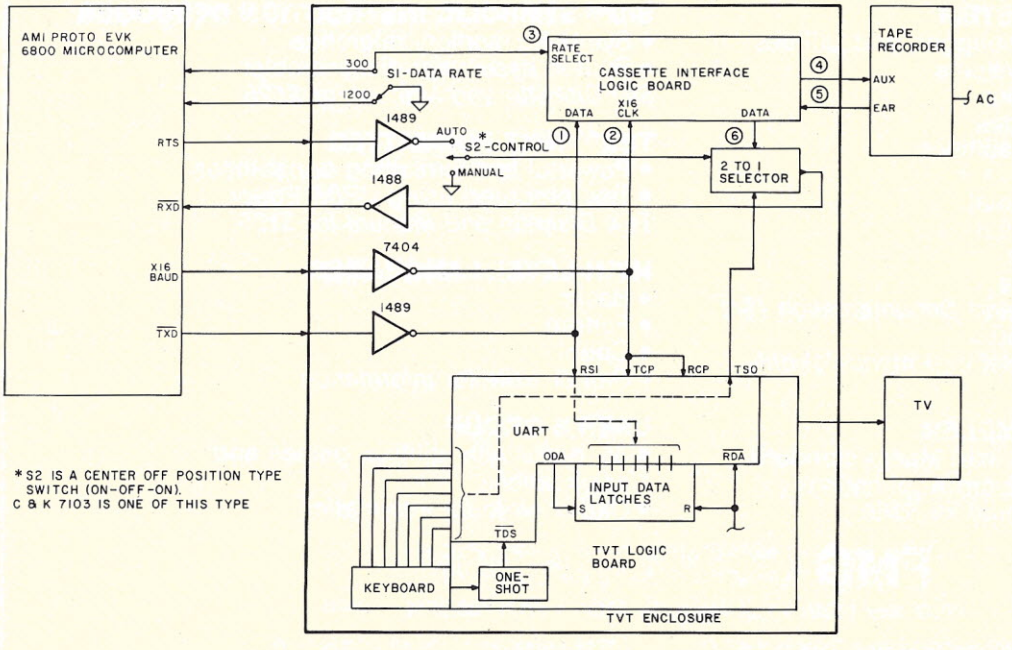


Fig. 1. Overall diagram of how system is interconnected.

IC	−5 V	Ground
U1	14	7
U2	14	7
U3	14	7
U4	14	7, 9, 10
U5	14	7
U6	8	1, 2, 4
U7	14	7
U8	16	1, 8

Table 2. Power wiring.

U1, U2, U3	7474
U4, U5	7400
U6	LM311
U7	74132
U8	74123
CR1, CR2	1N914
DS1	LED
R1, R3, R7	1k
R2	470
R4	100
R5	510
R6	10k
R8	50k (pot.)
R9	270
C1, C2, C5, C9-13	0.1
C3	1.0
C4	0.0022
C6	0.01
C7 (Mylar film)	0.033
C8 (solid tantalum)	15.0

Table 1. Parts list. Resistors are in Ohms, and capacitors are in microfarads.

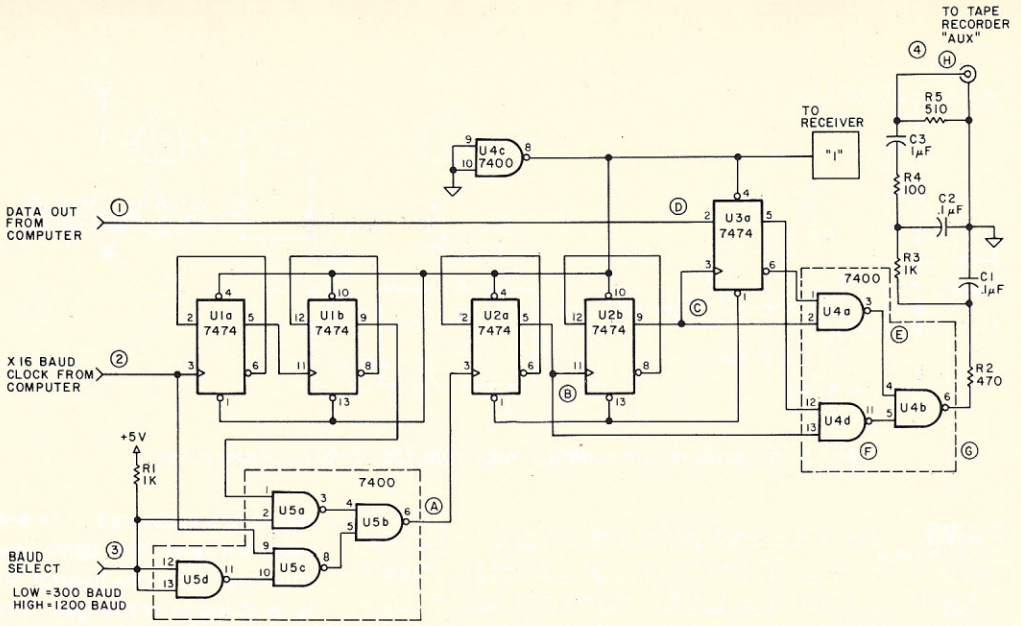


Fig. 3. Transmitter converts digital data to 1200/2400 Hz audio signals.

sette interface are picked up at TTL levels on the TVT inputs.

The data back to the computer is fed to a two-to-one selector circuit that allows automatic computer control via the RTS line or manual control for tape only or keyboard only data. Therefore, the tape interface is always active but dependent on other controls.

The software driver for this device is (at least for 6800 systems) a part of the standard read only memory (ROM) monitor. All 6800 systems contain punch and load subroutines using the S format, which was developed by Motorola as a memory loader/paper-tape puncher and was used in MIKBUG. For complete details on the format, refer to Motorola Engineering Note 100, MIKBUG/MINIBUG ROM.

To record a tape using this driver, set up the system for the punch command, turn the tape recorder to record and type a carriage return (CR). The data is displayed on the TVT and simultaneously recorded on the tape. To load a program, just play the tape before the start of data, type an L and a CR. The data source control switch (S2 in Fig. 1) must also be set in the correct position, either automatic or manual tape only (center off position of the switch). All other information for the loader is included on the tape.

The S format uses ASCII data codes (since it was designed to operate with a Teletype machine) resulting in inefficient and time-consuming tapes (yes, even at 1200 baud). However, its saving feature is that it is used by all 6800 systems, constituting a 6800 data code exchange standard. Most other microcomputer systems now have ROM monitors that have routines to punch and load data and can be used in a like manner. If one is not available, they are not difficult to write or can be obtained from computer clubs. For most systems, no new software is required to use the interface circuit.

The error rate of this circuit has been nil! Once it was installed and the tape recorder controls adjusted, there were no errors at either 300 baud or 1200 baud. This has also been the case for several other computerists who have constructed and installed it in their systems. This, perhaps, is the best operational feature of the circuit.

The interface is broken up into two functional sections: the transmitter and the receiver. The operation of these is covered in full detail as follows.

The Transmitter

The transmitter consists of ICs U1, U2, U3A, U4 and U5 as well as the output filter R2-3-4-5 and C1-2-3 (see Figs. 2 and 3).

The Baud Select Input controls the two-to-one selector (U5), which selects either the X16 clock for 300 baud (4800 Hz) with the input low or a prescaled (to 4800 Hz) X16 clock for 1200 baud (19.2 kHz) with the input high. In either case the output of the selector (point A) is a 4800 Hz square wave. U2 divides this by 2 (point B) and by 4 (point C) to derive the 2400 Hz and 1200 Hz for the audio tones ONE and ZERO, respectively.

The data (point D) is reclocked by U3A with the derived 1200 Hz to ensure that the data and tones are well aligned. Data ones gate the 2400 Hz through the output multiplexer (point F), and data zeros gate the 1200 Hz (point E). These are combined by U4B (point G) to form the composite 1200/2400 Hz data output.

Data ones at 1200 baud are two full cycles of 2400 Hz, and data zeros are one full cycle of 1200 Hz. At 300 baud a one is eight full cycles of 2400 Hz, and a zero is four full cycles of 1200 Hz (see Fig. 4). The output filter rounds off the sharp rising and falling edges of the square waves in an attempt to provide a sine wave to the tape recorder (point H).

The use of the computer X16 baud clock ensures the mini-

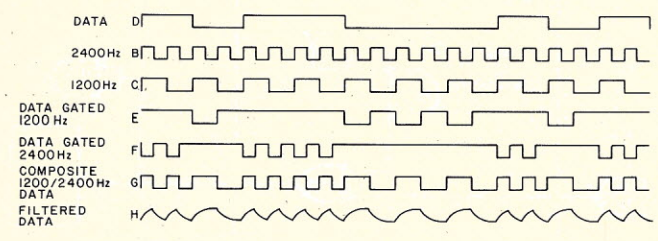


Fig. 2. Transmitter circuit timing diagram for key points and their relationships. All waveforms are for 1200 baud.

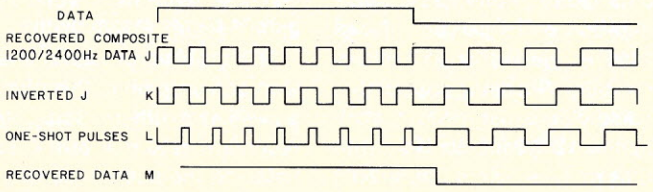


Fig. 4. Receiver waveforms for 300 baud data.

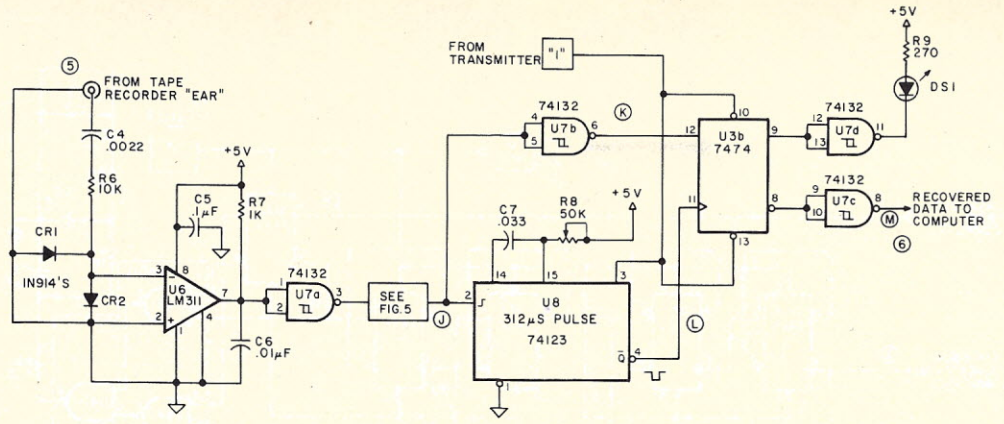


Fig. 5. Receiver recovers digital data from 1200/2400 Hz audio tones.

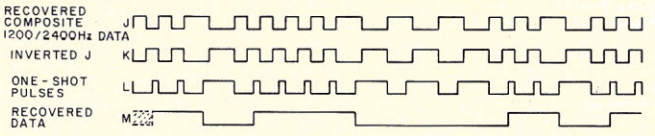


Fig. 6. Receiver waveforms for 1200 baud.

mum possible error between the data and derived tones, hence, the best output signal. It is strongly advised that this type of arrangement be used when this circuit is interfaced with a low-cost tape recorder. The filter components are selected to provide as near the same amplitude as possible between the 2400 Hz and 1200 Hz tones at point H.

The Receiver

The receiver consists of the input limiter (C4, R6, CR1-2), U6, U7, U8 and U3B (see Figs. 5 and 6).

The large signal from the tape recorder is ac-coupled via C4/R6 and limited to 1.4 V p-p by CR1/CR2. U6 converts the limited signal to square waves that are edge-smoothed by C6. Schmitt trigger U7A squares up the edges to trigger the one-shot U8 (point J in Fig. 5).

Note the waveforms for points J, K and L (see Fig. 6). It may be observed that the one-shot fires on the rising edge of the composite 1200/2400 Hz data (point J) and has a pulse duration of 75 percent of one 2400 Hz period or 312 microseconds. The rising edge of this pulse clocks the inverted composite 1200/2400 Hz data into U3B three-quarters into a 2400 Hz period.

The level of the composite 1200/2400 Hz data at this time is always correct for a one or a zero. This occurs twice for a one data bit and once for a zero data bit (1200 baud data) removing the composite 1200/2400 Hz from the data and resulting in true recovered data at U3B Q output. The data is taken from U3B $\overline{Q}$ buffered and inverted by U7C to be returned to the computer as the recovered data (point M). U7D turns on an LED for data ones—this is a great indication of data activity on the tape.

One point in the receiver section should be explained in more detail. The output of U6 has noisy edges due to the slow signal from the tape recorder; C6 filters out the noise and rounds off the edges of the square waves.

These slow rising and falling edges can create problems for a normal TTL gate. For this reason a Schmitt trigger (U7-74132) gate is used to reshape the waveform. A 7400 gate may or may not function properly in such an application. In any case, a Schmitt trigger-type gate is highly recommended.

The problem of signal inversion can crop up in this circuit as well as in others. Some tape recorders return inverted signals—to the audio tone this is no problem, but for ones and zeros it is. If the data is inverted, the recovered ones are extended and the zeros are shortened by a one-quarter bit for a string of any length. This can be very misleading because it seems to work.

The most straightforward solution is to add an exclusive OR gate at the output of U7A as shown in Fig. 7. With the switch in the normally closed (NC) position, the switched input is held low and the signal is not inverted; but in the normally open (NO) position the input is held high by the pull-up resistor and the signal is inverted. This allows external control for reading tapes from any recorder. Other switching arrangements could be implemented; if some other technique works better for you, then use it.

The receiver contains the only adjustment in the whole circuit—the one-shot pulse duration potentiometer, R8. With the circuit installed in your system (something like that of Fig. 1), connect the tape interface output back to its own input.

With no signal being sent from the computer, the data should be continuous ones resulting in 2400 Hz at the tape I/O point. U8 will be triggered on each rising edge, and the pulse out at U8 pin 4 should be adjusted to 312 microseconds by R8. If you prefer, you can select a fixed value resistor since no adjustment is needed after this one time.

As has been stated by others, it is the recorder that can cause the problems. I have a J.C. Penney cassette recorder ($40), which has been just great. After I found the optimum setting for tone and volume it has just worked and worked and worked.

Good power-to-ground bypassing techniques should be used. Use of one 0.1 microfarad capacitor for every two ICs is a good rule to follow (you will never know it didn't work without them). The power line to U6, an analog comparator, should be bypassed (C5) as close as possible to the IC. A decoupling capacitor (C8) of at least 15 microfarads (solid tantalum) should be used at the point where the power and ground enter the board.

With these precautions there should be no trouble in making this circuit work well for you.

Conclusions

The circuit described in this article fills the need for a single circuit design giving both a 300 baud Kansas City Standard and a high-speed cassette tape recorder interface. It is highly reliable at both data rates, even when used with a low-cost cassette tape recorder. It is easy to build and install in any type of computer system and is easy to use. I hope the illustration of how it is connected in a real operating system will be useful to those who would like to build and use the circuit.■

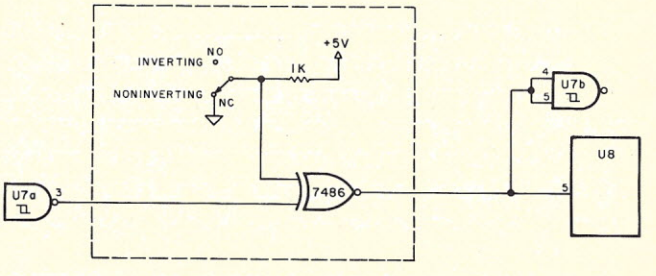
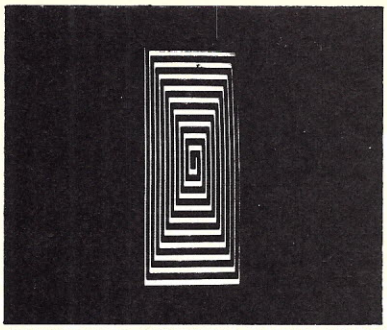
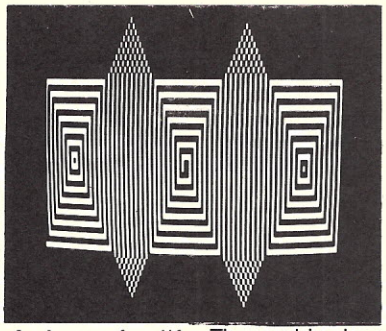
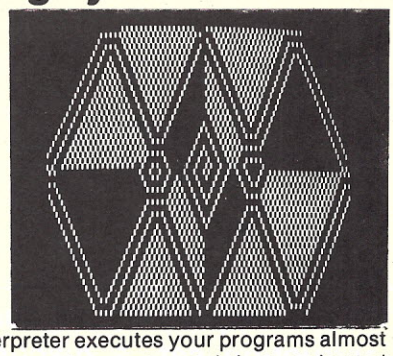


Fig. 7. Circuitry to be added for signal inversion.

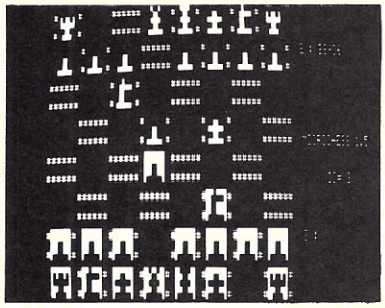
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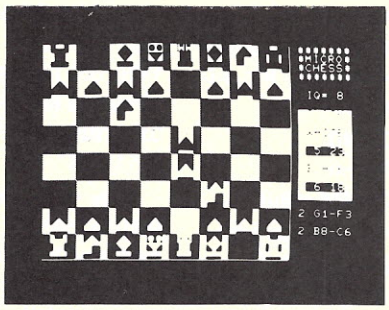


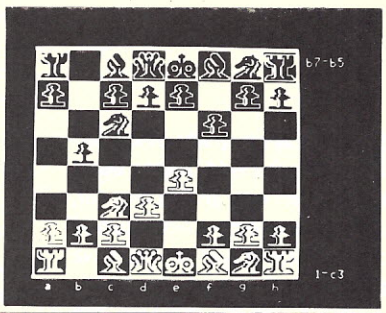




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How to Talk to Your 8080

This three-part article concludes in this issue with a description of the rest of the 8080 instruction set, a discussion of the stack and an introduction to hand assembling.

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In the first two parts of this series, we learned how to enter a program into the computer, the difference between hex and octal numbers and how to move data in and out of the 8080's registers and the memory. We learned about the flags, how to do arithmetic and, finally, discussed the branch instructions, jump and call.

This month's article will complete the series with a description of the rest of the 8080 instruction set, including the logic instructions. Then we'll discuss the stack and finish off with a neat programming method called hand assembling. There are lots of program examples, too.

The Logic Group and Rotates

Another set of instructions is used for logical comparisons. First let's talk about logical truth tables, which will help explain these instructions.

Here's an example of the truth table for the AND instruction:

A	B	R
0	0	= 0
0	1	= 0
1	0	= 0
1	1	= 1

You'll note that if A and B equal 1 then, and only then, does R equal 1.

AND comparison instructions "AND" each pair of bits in a byte. For example, if

A = 10111010 AND
B = 01001010 then
R = 00001010 is the result.

See how it works? We compare each bit of A and B, and if they are both 1 then the resultant bit in R is a 1; otherwise, it's a 0. Let's try another.

A = 11011010 AND
B = 10111001 then
R = 10011000 is the result.

The AND instructions are:

ANA,B	240	A0
ANA,C	241	A1
ANA,D	242	A2
ANA,E	243	A3
ANA,H	244	A4
ANA,L	245	A5
ANA,M	246	A6
ANA,A	247	A7

These instructions "AND" the contents of the register, or memory in the case of M, with the A register. All PSW flags are affected. The A register then contains the resulting number, or the R in our examples.

One use of the ANA instruction is to mask a number—that is, select certain bits of a number. Let's say we have 351 (E1 hex) in the A register and are only interested in the last octal digit, or bits 0-2. We want to put that digit in the A register. We could then use Program 1.

We now have 001 (octal) in the A register:

A = 11101001 AND
B = 00000111 then
R = 00000001

A = 00000001 or 001 octal, the last octal digit. We would use a similar method for hex but would AND with 0F to get the last hex digit (four bits).

But what if we only wanted the center digit of A, or 5 (A = 351 octal)? We'd use a new instruction, RRC. See Program 2. This RRC moves all the bits one position to the right each time it is used. So three RRCs would move bits 3-5 to bit positions 0-2:

11101001 then RRC to
11110100 then RRC to
01111010 then RRC to
00111101

Now we have the middle 5 (101) in the right three bits. Then we mask it with 007 to retrieve it as in the earlier program.

00111101 AND
00000111 then
00000101

We have to move the middle digit we wanted to the right 0-2 bits so we can isolate it. If we used:

MVI,B	006	06
	070	38
ANA,B	240	A0

we'd get

11101001 AND
00111000 then
00101000

or 050. This is not what we wanted, or 005. We could use Program 3, which would give us the same number, or 005.

The RRC instruction is called a *rotate*. We can rotate either way—RRC for a right rotate, RLC for a left. For example, we could rewrite the last program as Program 4.

Obviously, this is the long way around. But in some cases, the RLC would be faster. For example, if we wanted the first digit of octal 351, we could use Program 5.

We'd end up with 003 in the A register:

11101001 RLC to
11010011 RLC to
10100111
00000011 AND B
00000011 in A

Note that since the first octal digit is two bits long, we "AND" with 003 (00000011) instead of the 007 (00000111) we used for a three-bit number. You'll find this masking technique useful to isolate bits to manipulate as you wish.

The rotate instructions are:

RLC, 007 (07 hex), rotates contents of the accumulator left one position. The 0 bit and the carry bit (flag) are set to the old contents of the seventh bit position.

The rotate instruction, RRC, 017 (0F hex), rotates contents of the accumulator right one position and sets the 7 bit and the carry bit (flag) to the contents of the old 0 bit.

RAL, 027 (17 hex), rotates contents of the accumulator left one position through the carry bit and sets the 0 bit equal to the old carry bit and the carry bit equal to the bit shifted out of the seventh bit.

RAR, 037 (1F hex), rotates contents of the accumulator right one position through the carry bit and sets the seventh bit equal to the old carry bit and the carry bit equal to the bit shifted out of the 0 bit.

Another useful set of logical instructions is the OR group. The truth table for the OR group is:

A	B	= R
0	0	= 0
0	1	= 1
1	0	= 1
1	1	= 1

You'll note that if A or B equals 1, then R equals 1.

If we had 242 (A2 hex) in the A register and ORed it with 132

```
000   00    MVI,B    006   06    put 7 in B
001   01             007   07
002   02    ANA,B    240   A0    AND A and B
```

Program 1.

```
000   00    RRC      017   0F
001   01    RRC      017   0F
002   02    RRC      017   0F
003   03    MVI,B    006   06
004   04             007   07
005   05    ANA,B    240   A0
```

Program 2.

```
000   00    MVI,B    006   06
001   01             070   38
002   02    ANA,B    240   A0
003   03    RRC      017   0F
004   04    RRC      017   0F
005   05    RRC      017   0F
```

Program 3.

(5A hex) in the B register, we'd get:

A = 10100010
B = 01011010
R = 11111010

in the A register.

The OR instructions are listed below. Note that the named registers are ORed with the A register, and the results are placed in the A register. The named register is not changed. All flags are affected.

ORA,B	260	B0
ORA,C	261	B1
ORA,D	262	B2
ORA,E	263	B3
ORA,H	264	B4
ORA,L	265	B5
ORA,M	266	B6
ORA,A	267	B7

You probably won't use the ORs very often at first, nor will you use the XRAs, the next group. The XRA group is the logical exclusive OR. The truth table is:

A	B	R
0	0	= 0
0	1	= 1
1	0	= 1
1	1	= 0

You can see that if A or B, but not both, are 1, then R equals 1. To use the numbers from the previous example again:

A = 10100010
B = 01011010
R = 11111000

All flags are affected. The result ends up in the A register; the B register remains unchanged. The instructions are:

XRA,B	250	A8
XRA,C	251	A9
XRA,D	252	AA
XRA,E	253	AB
XRA,H	254	AC
XRA,L	255	AD
XRA,M	256	AE
XRA,A	257	AF

Note that if you use XRA,A you will always end up with 0 in A. So this is the same as MVI,A except the flags are affected. Move instructions don't affect the flags.

The next logical group is the compare instructions. These are like subtracting the register from A, but the result of the subtraction is not placed in the A register; both registers are unchanged. All flags are affected. These constitute a useful set of instructions. If both registers contain the same number, then the 0 flag will be set, as it will be if the register is subtracted from A, leaving 0. Remember, neither register's contents is changed by a compare, but the flags are affected as if a subtraction occurred. The instructions are as follows:

CMP,B	270	B8
CMP,C	271	B9
CMP,D	272	BA
CMP,E	273	BB
CMP,H	274	BC
CMP,L	275	BD
CMP,M	276	BE
CMP,A	277	BF

This group is so useful we'll give a sample program. Let's say you wished to put all 1s in a group of addresses. We could use Program 6. This is just one example of the use of comparison instructions. There are a few more instructions in this logic group:

ANI	346	E6
XRI	356	EE
ORI	366	F6
CPI	376	FE

As you have probably guessed, these are immediate instructions for an AND, exclusive OR, OR and compare. Thus, these are two-byte instructions —the second byte contains the data rather than a register; except for that they work like the earlier logical instructions. All flags are affected. Next we have three commands that don't fit conveniently elsewhere.

1. CMA 057 2F: This instruction complements the A register, that is, any 1 bit becomes a 0, and any 0 becomes a 1. So if A = 10110101, then CMA will cause A = 01001010.

2. STC 067 37: This one is simple, it sets the carry flag (in the PSW register) to a 1.

3. CMC 077 3F: This complements the carry flag, that is, if the carry flag is 0, it becomes a 1; if it is a 1, then it becomes a 0.

Special Move Instructions

Here are four somewhat complicated instructions:

XCHG	353	EB
SPHL	371	F9
PCHL	351	E9
Xthl	343	E3

The XCHG swaps the contents of the HL pair with the DE register pair. That is, the contents of the H register are placed in D, the contents of L in E, the contents of D in H and the contents of E in L.

This is useful if we have a memory address in HL we don't want to lose, but need to use HL for something else for a while. If the DE pair is free, we can use XCHG to store the HL pair in DE until we need it again. Then we can use another XCHG to get it back. This is a move so no flags are affected.

The SPHL instruction moves the contents of the HL register pair to the SP (stack pointer)

```
000   00    MVI,B    006   06
001   01             070   38
002   02    ANA,B    240   A0
003   03    RLC      007   07
004   04    RLC      007   07
005   05    RLC      007   07
006   06    RLC      007   07
007   07    RLC      007   07
```

Program 4.

```
000   00    RLC      007   07
001   01    RLC      007   07
002   02    MVI,B    006   06
003   03             003   03
004   04    ANA,B    240   A0
```

Program 5.

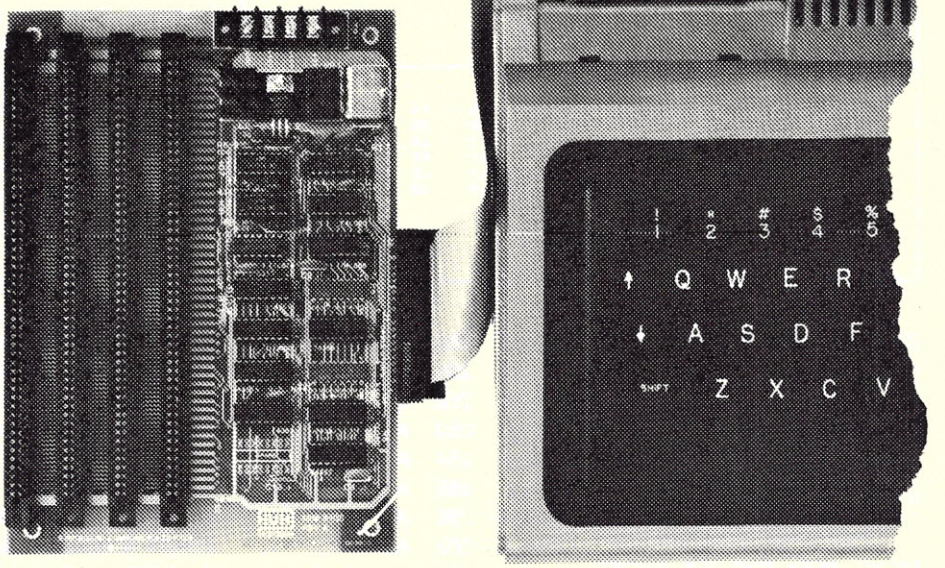
```
000   00    LXI,H    041   21    starting address
001   01             000   00    low half
002   02             001   01    high half
003   03    LXI,D    021   11    ending address
004   04             000   00    low half
005   05             002   02    high half
006   06    MVI,B    006   06    store the data
007   07             377   FF    the data, all 1s
010   08    MOV M,B  160   70    put data in HL address
011   09    MOV A,H  174   7C    put high address in A
012   0A    CMP,D    272   BA    compare high address
013   0B    JNZ      302   C2    not the same
014   0C             023   13    goto next storage address
015   0D             000   00
016   0E    MOV A,L  175   70    high was the same, try low
017   0F    CMP,E    273   BB    compare low address
020   10    JZ       312   CA    they match, we're done
021   11             027   17
022   12             000   00
023   13    INX,H    043   23    next address to store
024   14    JMP      303   C3    do it again
025   15             010   08
026   16             000   00
027   17    HLT      166   76    stop, we're done
```

Program 6.

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```
000     00      LXI,H     041     21
001     01                001     01
002     02                100     40
003     03      PCHL      351     E9
```

Program 7.

```
000     00      JMP       303     C3
001     01                001     01
002     02                100     40
```

Program 8.

```
000     00      PUSH,B    305     C5
001     01      CALL      315     CD
002     02                020     10
003     03                000     00
---     --
020     10      POP,B     301     C1
```

Program 9.

pair. We lose what was in the SP pair; now both HL and SP have the same contents, initially in HL. We'll discuss the stack in greater detail under its own heading. Again, since this is a move, no flags are affected.

The PCHL instruction moves the contents of the HL pair to the PC (program counter) pair. Now both HL and PC have the same contents. The PC register always contains the address of the current instruction being acted on by the program.

If the instruction is a jump or CALL, the PC pair is loaded with the address following the first byte of the instruction, that is, the address we are jumping to. Thus the PCHL is a sort of jump . . . but to the address stored in the HL register. For example, Program 7 is the same as Program 8.

The command is useful if you already have the address you wish to jump to in the HL pair. Then you save two bytes (three for a jump, one for PCHL). If the address is in the DE pair, you can save one byte by using XCHG and PCHL rather than JMP.

Normally, except for the following instructions, the PC pair is automatically incremented to the address of the next instruction after each instruction has been concluded. In the case of the JMP or CALL, or in a conditional jump or call if the conditions are true, the PC is set to the address in the two bytes following the immediate data.

Complicated? Probably a little, but all I'm saying is that the PC always goes to the next instruction to be performed, not to the data following a multibyte instruction.

Now to the XTHL instruction. This is a tricky one, so we'll skip it for the moment while I explain the stack.

The Stack

The stack is an area in memory you designate when you use the LXI SP instruction. This determines the address of the stack. You should have plenty of free area below the stack (lower memory addresses).

A good place to put the stack is at the top of memory (highest memory address in your computer). The stack constantly grows and shrinks as the program progresses. Putting it at the top of memory gives it plenty of room to grow. In this case be sure your program doesn't write over the stack area.

You could also reserve the first 20 or 30 memory addresses for the stack by setting the stack pointer to 000/024, 0014 hex or 000/036, 001E hex (24 octal is 20 decimal; 36 octal, 30 decimal). Then use the addresses following the stack pointer for your program. Examples of programs using a stack appear later.

If you have a CALL or conditional call in your program, there will be a return to the program following the CALL after the end of the subroutine you called. The PC is at the return, so how does it know where to return?

We want to return to the instruction following the call, as we saw in the sample program. But we didn't store that address anywhere. So how does the PC know what it is? Simple, we store the next instruction address on the stack when we have a call instruction. This is done automatically by the processor.

Let's say the SP is set to 000/024 (0014 hex). When we do the call, the SP is decremented by 1, then stores the low half of the return address (that following the three-byte call instruction) at 000/023 (0013 hex). The SP is decremented again and stores the high half of the return address at 000/022 (0012 hex).

When the PC gets to the return instruction in the subroutine, the SP puts the contents of the address to which it is pointing into the high half of the PC, then the SP is incremented and stores the contents of that address (000/023, 0013 hex) into the low half of the PC register pair. Then the PC is incremented again to 000/024, 0014 hex, and we are back where we started, but the PC is now addressing the address after the call.

We can have a subroutine call another subroutine, which can call another subroutine, and so on. We might have several addresses in the stack, but the SP always points to the one most recently stored. That is one reason we want plenty of room in the stack. Another reason is that we have other ways of storing data in the stack, as we will see. First, let's reexamine the XTHL instruction.

SP	Stack Pointer Address	Data Hex	Octal	Hex
	000/024	0014	000	00
	000/023	0013	173	7B
	000/022	0012	022	12
	000/021	0011	164	74
---->	000/020	0010	001	01
After XTHL				
	000/024	0014	000	00
	000/023	0013	173	7B
	000/022	0012	022	12
	000/021	0011	242	A2
---->	000/020	0010	003	03

Table 1.

This instruction moves the data in the address in the SP pair into the HL pair. It replaces the address that was moved to the HL pair from the SP address with the address that was in HL. So the top of the stack (or the bottom, depending on how you look at it) is exchanged with the HL contents. The SP register pair contents remain the same, but it is now pointing to a new stored address. Let's see if a diagram won't make this clearer.

The address in HL is 003/242 (03A2 hex). See Table 1. The address in HL is now 001/164 (0174 hex).

See how it works? I warned you it was tricky. Note that the contents of the SP pair remain the same (000/020, 0010 hex), but the contents of HL and the top of the stack are exchanged. This is a move, so no flags are affected. Naturally the addresses are exchanged properly—the low address in the stack goes to L, the high address to H and vice versa.

We mentioned that there are other ways to use the stack. Here are the instructions:

PUSH B	305	C5
PUSH D	325	D5
PUSH H	345	E5
PUSH PSW	365	F5
POP B	301	C1
POP D	321	D1
POP H	341	E1
POP PSW	361	F1

The PUSH instructions put the contents of the named register pair on the stack, just like the call instructions. Using the BC pair as an example, the contents of the B register are stored at the SP address, 1, the C register at the SP address, 2, and the contents of the SP pair are decremented by 2.

The POP instructions work like the return. Using the BC pair as an example, the contents of the stack pointed to by the address in the SP pair are moved to the C register, the SP is incremented, the next data goes to B and the SP is incremented again. So we PUSH to store the data contained in a

register pair, then POP to get it back in the same or another register pair.

Note that we can't use Program 9 because we'd get back the CALL return address in the BC pair instead of the data we stored. Consequently, we must be careful about putting a POP in a subroutine unless we have a PUSH in the same subroutine. We can also use

PUSH B 305 C5
POP D 321 D1

moving data from the BC pair to the DE pair. However, it would be faster to use:

MOV D,B 120 50
MOV E,C 131 59

Incidentally, the PUSH and POP PSW refer to the A and PSW registers.

A Sample Program and Hand-Assembly Techniques

Let's try a sample program using some of these new instructions. This will be a memory-test program that checks each address with all 0s, all 1s and alternating 0s and 1s. The idea behind this test is to make sure every memory bit will store a 1 or a 0 and to be sure two bits aren't changing when only one should.

If we don't get back what we stored, we go to the ERROR routine, store the data, good and bad, together with the address where the error occurred, then halt the computer. In this example I will also introduce a technique called *hand assembling*. To use it we use labels for memory addresses instead of numbers, then fill in the numbers later, so the jumps and calls will be written to a label, not to an address. Don't worry —I'll explain it all later. By the way, NOP (000) means no operation, skip this instruction. See Program 10.

First, I'd better admit I haven't checked this program to see if it really works. The object of this article is to teach machine-language programming, not give you a program to test memory. I just used this program as an example of the use of various instructions. However, I think it will work.

Your homework assignment is to figure out how the program works by reading the comments and looking back to see how the instruction works. This will be good practice for you. You should also see if you can discover any errors in the program. The program uses most of the kinds of instructions I have described so far.

Now, About Those Labels.

You will note I made up a short label for each part of the program that repeats (that the program jumps to or calls). I put this alongside the appropriate instruction. Also, I didn't use addresses when I first wrote the program, I used the labels instead. I wrote the label under the mnemonic that required the address.

When I wrote the program I left off all the addresses you see on the left of the listing and used only labels, mnemonics and comments. When I had the program finished, after changing, adding or deleting a line here and there, I filled in all the addresses, starting at 000. Then I filled in all the label addresses by noting the address at that label. Finally, I filled in all the octal and hex op codes for the instructions.

The beauty of using this method is that I could write the main program, then go back and write each subroutine required. If I made a mistake, and

```
000   00          NOP         000   00   put 0 in address 0
001   01          NOP         000   00   put 0 in address 0
022   12          LXI,SP      061   31   set stack
023   13                      022   12   use first 18 addresses
024   14                      000   00   for stack
025   15          LXI,H       041   21   starting address
026   16                      XXX   XX   low half
027   17                      XXX   XX   high half
030   18          LXI,D       021   11   finish address
031   19                      XXX   xx   low half
032   1A                      XXX   XX   high half
033   1B          MVI,B       006   06   first test data
034   1C                      000   00
035   1D          MOV A,B     170   78   move 0 to A
036   1E          MOV C,A     117   4F   move 0 to C
037   1F          PUSH H      345   E5   save start address
040   20          CALL        315   CD   memory check address
041   21          CHKMEM      074   3C
042   22                      000   00
043   23          MVI,B       006   06   second test data
044   24                      377   FF
045   25          MOV A,B     170   78   put in A
046   26          POP H       341   E1   retrieve starting address
047   27          PUSH H      345   E5   store it again
050   28          CALL        315   CD   memory check
051   29          CHKMEM      074   3C
052   2A                      000   00
053   2B          MVI,B       006   06   third test data
054   2C                      252   AA
055   2D          MOV A,B     170   78   put in A
056   2E          POP H       341   E1   retrieve start address
057   2F          PUSH H      345   E5   store it again
060   30          CALL        315   CD   memory check
061   31          CHKMEM      074   3C
062   32                      000   00
063   33          MVI,B       006   06   fourth test data
064   34                      125   55
065   35          MOV A,B     170   78   put in A
066   36          POP H       341   E1   retrieve start address
067   37          PUSH H      345   E5   store it again
070   38          CALL        315   CD   memory check
071   39          CHKMEM      074   3C
072   3A                      000   00
073   3B          HLT         166   76   finished
074   3C  CHKMEM  MOV M,A     167   77   store test data
075   3D          MOV A,M     176   7E   retrieve test data
076   3E          CMP,B       270   B8   the same?
077   3F          JNZ         302   C2   no
100   40          ERROR       136   5E
101   41                      000   00
102   42          INX,H       043   23   yes, next address
103   43          CALL        315   CD   last address?
104   44          CHKADR      112   4A
105   45                      000   00
106   46          JNZ         302   C2   no, test another address
107   47          CHKMEM      074   3C
110   48                      000   00
111   49          RET         311   C9   yes, finished so far
112   4A  CHKADR  MVI,A       076   3E
113   4B                      001   01   last address flag
114   4C          CMP,C       271   B9   is it flagged?
115   4D          RZ          310   C8   return if last address
116   4E          MOV A,H     174   7C   check for high
117   4F          CMP,D       272   BA   last address
120   50          JNZ         302   C2   no, put data back in A
121   51          RESET       132   5A
122   52                      000   00
123   53          MOV A,L     175   7D   check for low
124   54          CMP,E       273   BB   last address
125   55          JNZ         302   C2   no, put data back in A
126   56          RESET       132   5A
127   57                      000   00
130   58          MVI,C       016   0E   yes, flag last address
131   59                      001   01   last address flag
132   5A  RESET   MVI,A       076   3E   put 0 in A
133   5B                      000   00
134   5C          ADD,B       200   80   return data and set Z flag to
135   5D          RET         311   C9
136   5E  ERROR   POP D       321   D1   get rid of stored address
137   5F          PUSH H      345   E5   save error address
140   60          MOV C,A     117   4F   put error data in C
141   61          PUSH B      305   C5   push good and bad data
142   62          HLT         166   76   stop
```

Program 10.

```
000  00  PROMPT   LDHL     052  2A   set HL to read letters
001  01            STRADR   030  18
002  02                     000  00
003  03  WRITE    CALL     315  CD   print it
004  04            PRINT    013  0B
005  05                     000  00
006  06            RLC      007  07   last letter?
007  07            JNC      322  D2   no, do again
010  08            WRITE    003  03
011  09                     000  00
012  0A            HLT      166  76   stop
013  0B  PRINT     IN       333  DB   get status byte from
014  0C            0        000  00   I/O board at port 0
015  0D            RAL      027  17   test status
016  0E            JC       332  DA   not ready,
017  0F            PRINT    013  0B   try again
020  10                     000  00
021  11            MOV A,M  176  7E   get letter
022  12            ANI      346  A6   get rid of 1 in 8th bit
023  13                     177  7F   if present
024  14            OUT      323  D3   send data to
025  15            1        001  01   terminal I/O port
026  16            INX,H    043  23   next letter
027  17            RET      311  C9
030  18  STRTAD    "S"      123  53   ASCII "S"
031  19            "T"      124  54
032  1A            "A"      101  41
033  1B            "R"      122  52
034  1C            "T"      124  54
035  1D            "space"  040  20
036  1E            "A"      101  41
037  1F            "D"      104  44
040  20            "R"      122  52
041  21            "?"      077  3F
042  22            "space"  240  A0
```

Program 11.

```
000  NUM      CALL     315  get first digit
001            GETNUM   032
002                     000
003            ANI      346  AND with 003 to
004            003      003  get rid of other bits
005            RRC      017  rotate number to put
006            RRC      017  digits in bits 6 & 7
007            MOV B,A  107  store in B
010            CALL     315  get second digit
011            GETNUM   032
012                     000
013            ANI      346  AND with 007 to get
014            007      007  rid of extra bits
015            RLC      007  rotate number to
016            RLC      007  move it to bits
017            RLC      007  3, 4 and 5
020            ORA,B    260  OR (merge) with B
021            MOV B,A  107  move result to B
022            CALL     315  get third digit
023            GETNUM   032
024                     000
025            ANI      346  AND with 007 to
026            007      007  get rid of extra bits
027            ORA,B    260  OR (merge) with B
030            MOV B,A  107  move result to B
031            HLT      166  finished
032  GETNUM    IN       333  see if I/O board
033            0        000  has a new digit
034            RAR      037  check bit 7
035            JC       332  no, try again
036            GETNUM   032
037                     000
040            IN       333  yes
041            1        001  get digit
042            RET      311  return to program
```

Program 12.

I did, I could erase (I write in pencil) and replace the instruction or squeeze in the added instructions until I thought I had everything right. There was no bother about changing all the addresses if I had to add or delete an instruction because there were no addresses yet. Only after I corrected the program did I fill in the address for each instruction and put the label addresses in the program.

If I wish to change the program later, I'll just erase the addresses and label addresses, make my changes, then renumber all the addresses and put in the new label addresses. The labels help me remember where all the jumps and calls go.

Essentially, this is what an assembler program does for you. You write the program using mnemonics and labels. The assembler fills in all the memory addresses, just as I did by hand. That's why the technique is called hand assembling. It's a pleasant way to write machine-language programs.

Try it. I'm sure you'll like it.

The RST Instructions

Now, after this last group of instructions we will be through with the instruction set. These are the RST instructions. They are generally used to store interrupt routines (that can of worms I won't open in this article, but you can use them in your programs if you wish).

They give you eight dedicated addresses in memory, each with eight usable addresses following to store a short routine. They are useful because they are jumped to by a single-byte instruction (a normal jump takes three). They cannot be conditional jumps or calls. See Table 2.

To use a longer routine you could refrain from using the next RST number to leave that area free for the additional instructions.

Data Input/Output Routines

One last technique I should mention is how to use ASCII-coded alphanumerics in your program to prompt for input data, printout tables, etc. If you are using a terminal you'll want to use this technique in your programs.

Let's say we want to print out a prompt for the starting address of the memory-test program. (If it gets much longer you won't have any memory left to test!) We'll assume you are using the Mits SIO I/O board. We'll also assume the board is addressed for port 0. This is the way it is set for Mits software. We'll start the program at 0 in memory; I won't try to add it to the test program.

If you should happen to try this by itself to see how it works, be sure to assign a stack somewhere with an LXI SP. By using the hand-assembling technique, you can easily relocate it. The ASCII codes can be found in many references. See Program 11.

RST0	307	C7	jump to 000/000	0000
RST1	317	CF	jump to 000/010	0008
RST2	327	D7	jump to 000/020	0010
RST3	337	DF	jump to 000/030	0018
RST4	347	E7	jump to 000/040	0020
RST5	357	EF	jump to 000/050	0028
RST6	367	F7	jump to 000/060	0030
RST7	377	FF	jump to 000/070	0038

Table 2.

```
000              MOV A,M  176  get data to send
001              RLC      007  move first number
002              RLC      007  to bits 0 and 1
003              ANI      346  mask with 003 to
004              003      003  get rid of extra bits
005              CALL     315  print it
006              CHROUT   030
007                       000
010              MOV A,M  176  get data
011              RRC      017  move second
012              RRC      017  digit to
013              RRC      017  bits 0, 1 and 2
014              ANI      346  mask
015              007      007
016              CALL     315  print it
017              CHROUT   030
020                       000
021              MOV A,M  176  get data
022              ANI      346  mask
023              007      007
024              CALL     315  print it
025              CHROUT   030
026                       000
027              HLT      166  stop
030  CHROUT      ORI      366  add 060 to convert
031              060      060  to ASCII number
032              PUSH PSW 365  save number
033  STATUS      IN       333  get status
034              0        000  status port
035              RAL      027  ready to send?
036              JC       332  no, try again
037              STATUS   033
040                       000
041              POP PSW  361  yes, get number back
042              OUT      323  send it to terminal
043              1        001  data port
044              RET      311  return
```

Program 13.

The PRINT routine inputs the status byte from the I/O board. In the case of the Mits SIO board, the 7 bit is 1 if the I/O board is in use, 0 if the I/O board is ready to output a character. If ready, we go to the OUT instruction to load the character we wish to send to the terminal.

The full set of ASCII characters only requires seven bits, so we use bit 7 (the eighth bit) as a flag to tell the routine that this is the last character in the string. We set it to 1 to do so because it is normally 0 for an ASCII character code. We set the last character, the final space, to a 1 by making the code 240 instead of the normal 040. Then we rotate left after sending each character to see if it was the last by checking for a 1 in the carry bit (rotated out of bit 7).

Data such as these prompts should be set off by themselves in memory after the program. This keeps data and program separate, a good programming practice. You will see many advantages in doing this after you program for a while. For now, it's a good habit to assume.

To get the answer to the prompt of the previous example, we have to do some bit manipulation. Let's say we are getting the low half of the address we just prompted for. Note that Programs 12 and 13 are set up for octal numbers, so no hex equivalents are given. An interesting project would be to rewrite the programs for hex numbers. Again, we'll start at 0 and let you relocate it. We'll end up with the three-digit octal number in B. See Program 12.

As our last I/O routine, let's say we want to write the data in an address on the terminal. We'll assume the data address is already in HL. See Program 13.

Again I'd better mention that the status port of the SIO board is assumed to be set to 0. We always use an IN to get the status byte in A to check status before inputting or outputting a character to or from the terminal at port 1. Other I/O boards might require a different routine to do an IN or OUT.

In Conclusion

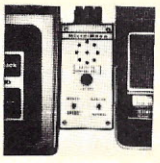
Remember, I don't guarantee that any of the programs used as examples will run—I am only using them as examples; as far as I know they are accurate. As mentioned earlier, it would be good practice for you to check these programs to see if they will run, and if they don't, figure out why and fix them.

I advise you to either get a printed card with the 8080 instruction set or, better yet, make up your own reference sheet with the op codes and mnemonics. Have fun talking to your 8080. ■

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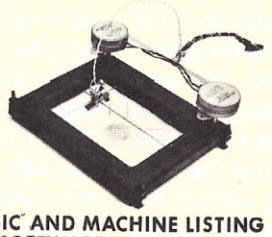
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Data Base Management

This article presents an introduction to the subject of data base management.

The power of the computer lies in its ability to manipulate large amounts of information very rapidly. To my mind, data base management refers to entering information into the computer, manipulating it and getting it out of the computer in a predetermined format.

What kind of information comprises a data base? It can be virtually anything. Right now I am keeping data bases that vary from the membership list of a nonprofit corporation (the Personal Communications Foundation) to a status report on orders, invoicing and deliveries of daisy-wheel printers, which I am selling, to a list of all amateur radio contacts I have ever made.

Please note that I have no formal background or training in computers. All I know is that I had a considerable amount of difficulty learning what is contained in this article. My descriptions and definitions may not be absolutely technically correct, but rather are the conceptualizations I developed to understand creating and manipulating data bases.

Since I have a Micropolis disk system, I will discuss concepts in terms of Micropolis disk BASIC. However, I will keep the discussion general enough so it can be applied to any system. After discussing the generalities, I will get into the specifics of a data base management program written for Micropolis disk by Helmar Herman. That is the data base management program I use.

Terms Defined

Several terms of art are used when you speak about data bases. A *file* refers to the entire data base. For instance, the data base for the Personal Communications Foundation is held in a file called "PCFMEMBERS." The PCFMEMBERS file contains all membership information on all members. I keep each file on a separate diskette.

On my system, using a Micropolis quad density disk drive, a file will hold as many as 1216 members. Any one of those possible 1216 entries is referred to as a record. A record can be though of as all information pertaining to one individual member.

In PCFMEMBERS each record consists of the member's first name, last name, address, city, state, zip code, membership classification (a one-digit code), month and year of membership expiration (a four-digit code), call sign and telephone number. Each of those individual pieces of information in any individual record is referred to as a *field* (i.e., first name field, last name field, address field, etc.).

Fields can be of a fixed or variable length. Fixed length means that a certain number of characters are reserved in each record for a specific piece of information. In PCFMEMBERS the first name field is always 15 characters in length. That is true even if a specific member's first name is John, which is only four characters long. With fixed length fields, if a piece of information is less than the length of its field, the remainder of the field is padded with blanks.

When using variable length fields, you can pack the information into the record with what is known as a *string delimiter*, indicating the end of the field. That is, in place of a field padded with blanks, the piece of data merely has a string delimiter tacked onto it. It is then immediately followed by the next field.

A string delimiter can be any ASCII character. However, it usually will be a character that will never appear in the data base, so that there is never any mistake as to where one field ends and another begins. If the string delimiter were a comma, you couldn't enter a comma in the data base . . . or the computer would think you were ending one field and beginning the next.

In Micropolis BASIC the string delimiter can be defined to the program by using the STRING command. Often a hex "FF" is used as the string delimiter. The hex "FF" is a nonprinting character so far as your keyboard is concerned and will never appear in any information that you wish to put into the data base.

With variable length fields, the size of any individual record in a file need never be the same. With fixed length fields, the size of each record in the file is always identical. Furthermore, with fixed length fields, the first character in any particular field always appears in the same position in the record.

The advantage of the variable length field is that more data can be packed onto a diskette. The advantage of a fixed length field, so far as I am concerned, is that data base manipulation is much easier.

In Micropolis BASIC each record can consist of up to 250 characters. If all of the fields in a record of my data base management program require less than 250 characters, the remainder of the record will be padded with blanks. In fact, it is easy to conceptualize a record as a 250-character string.

With fixed length fields, each field begins at the same position in each record. That is, in PCFMEMBERS the first name field always begins at character 6; the last name field always begins at character 21, etc. The beauty of the fixed length field is that any individual field of information can be accessed by using the MID$ function.

The MID$ function has the format MID$(X$,N,Y). What it does is return Y characters from X$ starting with character N. That is, if the 250-character record is assigned X$, you can pull any field in the data base out of the record by specifying where the

field begins (N) and the number of characters of which it consists (Y). The ability to manipulate a record as a string proves invaluable in a number of situations.

When I set up the PCFMEMBERS data base, I neglected to include the year of expiration along with the month of expiration. Using the MID$ function, I broke up each record after the month of expiration and added two characters to the expiration fields. I then appended the remaining fields onto the record after the now four-character expiration field. That saved my having to type the data base into the computer again.

Another example of how the string can be manipulated is by determining the number of members of each membership class by using the MID$ function on the membership classification field. There are four classes of membership: coded 1, 2, 3 and 4. I merely let a string variable equal MID$(X$,130,1), which defines the membership classification field. By using a loop going from record number one to the size of the file and incrementing one of four numeric variables depending on the membership code, you can easily determine the totals.

Using fixed length fields also makes it easy to reorder the records as desired. That is, by running a sort on the zip field, you can rearrange the file so that it may be printed in zip-code order.

The Program

I purchased the Data Management System program written by Helmar Herman (Creative Computing Applications, 2218 Glen Canyon Road, Altadena CA 91001) for $150, including a sort/merge program. I purchased the program because it was written in Micropolis BASIC, and it seemed suited for my needs.

It is a menu-driven program, which means that when you load it, it brings up a menu from which you choose the action you wish to take. There are four basic choices: You may define a new data base to the system, perform file maintenance on a data base (add, update or delete records), print out the information in the data base or compact files (purge the data base of deleted records).

Defining a New Data Base

Defining a new data base involves naming the data base file and identifying all of the fields that will be associated with records in the data base file. The names, beginning positions and lengths of all the fields are saved automatically in a file, called MAINTFILE, which is generated by the program.

You must first understand that the program reserves the first four characters in any record for the record number. The fifth character is also reserved for the "delete flag." Therefore, the first character that is available for definition to the system is character number six.

After you select the function that defines the data base system, the program asks that you enter the file name. It then asks for information regarding each field. Four pieces of information for each field must be entered: the field ID, the field name, the starting position of the field and the length of the field (see Example 1).

The field ID is an abbreviation of up to five characters for the name of the field. The name of the field may be up to 15 characters long. The starting position of the first field is always 6 as the program has reserved the first five positions for the record number and the delete flag. A field may be up to 244 characters in length, but if it is that length, there can only be one field.

Actually, there can be up to 24 separate fields as long as the total number of characters allocated to all fields does not exceed 244. The 244 limitation is derived by taking the 250-character record length and subtracting 4 for the reserved record number field, 1 for the reserved deletion flag field and 1 for the hex "FF" end of record indicator. After all of the field information is entered, simply typing a return, after the program asks for the next field ID, tells the program that there are to be no more fields.

It should be noted that a numeric field may be specified by typing an asterisk (*) prior to the field ID. The program also provides for preventing a field from being updated by entering an exclamation mark (!) prior to the field ID. The value in specifying numeric fields is that the program has a provision to add values entered into specific numeric fields.

FILE PCFMEMBERS

ID	NAME	START	LENGTH
FN	FIRST NAME	6	15
LN	LAST NAME	21	30
ADDR	ADDRESS	51	40
CITY	CITY	91	30
STATE	STATE	121	2
ZIP	ZIP	123	7
CLASS	MEMBER CLASS	130	1
EXP	EXPIRATION	131	4
CALL	CALL	135	9
TELE	TELEPHONE	144	15

Example 1. PCFMEMBERS file.

The data base definition portion of the program also provides for the ID, name, start position and length to be printed out (Example 1). You may also list the file names of all data bases that are defined to the system. It is also possible to delete data base definitions from MAINTFILE.

File Maintenance

After the data base has been defined to the system, you can then enter the items of data into the computer by using the file maintenance portion of the program. After you tell the program with which file you wish to work, the program asks you whether you wish to add, update, delete, scan or inspect a record.

If you select "add," the program then prompts you by printing the name of the first field. After that information is entered, a return causes the program to prompt with the name of the second field until such time as all fields have been entered. The program then tells you what record number has been added and allows you to again choose one of the file maintenance functions.

The "inspect" function merely lists all of the fields in the record number specified with the field name on the left side of the screen and the field data on the right. The "update" function allows corrections to be made. While in update, you just have to enter the field ID and the new information to go in that field. It is possible to update more than one field in a specified record at any one time.

If you select the "delete" function, the program lists the record and asks you to confirm that it is the correct record. If you type YES, the program inputs an asterisk in character position five. The record is not actually then deleted but is merely "flagged" for deletion. The "compact" function must be used to delete the record. An "update" of a record flagged for deletion removes the delete flag asterisk.

It is also possible to scan the data base for a particular piece of information. When choosing that function, you merely tell the program at what record number it should start its scan, the field ID of the field to be scanned and the data for which the program should scan. If the data is found, the number of the record or records in which the scan data appears is listed.

Compaction

As indicated before, compacting the data base purges it of records that have been flagged for deletion. The program allows several options in doing the compaction. It is possible to create a new file consisting only of records not flagged for deletion or to compact the file in place—that is, delete the records that have been flagged for deletion. It is also possible to create a backup file in conjunction with either of

the above described options.

Report Generator

The program provides for both horizontal reports (Example 3) or reports printed vertically in a "mailing label" format

```
Danville S.  Webber
100 Linden
Bangor  ME  04401
1  1278


Philip K.  Baldwin
RFD 2
Northfield  VT  05663
1  0979


John L.  Giulietti
314 Kelly Rd.
Vernon  CT  06066
1  0579


Mark Wertheim
682 Prospect Ave.
Hartford  CT  06105
2  1278
```

Example 2. Mailing label format. Program strips off blanks added as padding and puts two spaces in between fields. Note that the bottom line is membership code and expiration code.

(Example 2). When the report generator function is selected, the program requests "run options." The run options relate to the format of the report (horizontal or "mailing label"), the depth of the report (number of lines per page), the width of the report (number of columns per line), whether the report is to be printed on the terminal or the printer, the title of the report, whether or not the deleted records are to be printed and the name of the file to be printed.

It also provides for specifying the name of the file as it is defined to MAINTFILE, as opposed to the name of the file to be printed. This is important where the master data base is to be printed pursuant to some specified sorting sequence. That is, oftentimes I will want PCFMEMBERS to be sorted by zip and then have labels printed. The name of the zip-sorted file is called PCFZIP, which is not defined to the system. Therefore, I must tell the program that although it is printing PCFZIP, it should use the data base definitions set forth in PCFMEMBERS.

It is possible to print any or all of the fields in the data base. That is convenient since there is no reason to print the telephone number on a mailing label. It is also possible to only print a portion of any field. So even if you have specified that an address field may consist of 40 characters, it is possible to only print the first 30 characters in the field. This is useful if you are using mailing labels that are 3½ inches wide. If you are typing in ten pitch, the label would only be large enough for 35 characters.

Of course, you may specify that the fields be printed in any order desired. In the horizontal report format the program automatically labels the columns to be printed and inserts two spaces between each field as it is printed.

PCFMEMBERS

REC	FIRST NAME	LAST NAME	ADDRESS	CITY	ST	ZIP	C	EXP	CALL
158		Capitol City Hi	205 Ashwood Way	Harrisburg	PA	17109	1	0279	
88	Perry F.	Williams	225 Main St.	Newington	CT	06111	2	0279	
275		Fairfax React T	P.O. Box 432	Springfield	VA	22150	1	0279	
225	George P.	Firmin	1401 Dallas Circle	Marietta	GA	30064	1	0279	
205	Vinson C.	Thompson	625 E. 35th Street	Baltimore	MD	21218	2	0279	
203	John	Butrovich III	843 W. Ave. H P.O. Box 501	Kingsville	TX	78363	2	0279	W5UWB
195	John C.	Nery	22 Otis Ave.	Ware	MA	01082	1	0279	
232		TRW Systems ARC	One Space Park	Redondo Beach	CA	90278	2	0279	
330		CB Today	P.O. Box 511	Greenwood	IN	46142	2	0279	

Example 3. Report format.

Sort and Merge

Once all of the data is entered, you will, in all probability, want to rearrange the order of the data to make a meaningful report. For example, the Personal Communications Foundation data base has approximately 700 entries. For purposes of sending out renewal notices, PCFMEMBERS must be ordered by the expiration field so that all members whose membership expires in a particular month can be sent notices. However, in mailing the quarterly newsletter it is necessary that the file be sorted to zip-code order because that is a requirement of the post office in order to make bulk mailings at the nonprofit corporation mailing rates.

The sort program allows the data base to be sorted by as many as ten keys. This means that, if I desire, I can sort the file first by state, then by zip code within each state, then by alphabetical order of the members' last names within each zip code, etc. The sort/merge program creates a new file from PCFMEMBERS, which is sorted in the manner specified. The report generator can be used to print a report showing the result of the sort.

By the way, the sort for any key can be executed in ascending or descending order (i.e., a zip sort in ascending order would start with the zip code 00000 and end with zip code 99999).

The merge program comes into play when there are more records to be sorted than can be handled in the computer's memory at any one time. My system contains 56K of memory. Even with that amount of memory, it can only hold approximately 150 records at one time. Therefore, it is necessary that I use the merge program when sorting the PCFMEMBERS file.

The merge program works by determining the amount of memory available in the computer and dividing that by the length of the record. It then determines how many records can be worked on at once. It breaks the file into "sub-strings," each of which consists of the number of records that can be manipulated inside the memory of the computer at any one time; then each sub-string is sorted.

After all the sub-strings are sorted, the merge program pulls records off the top of each sub-string and puts those in order until each sub-string is exhausted. The resulting file consists of the original file sorted into its proper order.

The sort program creates two work files called "sortseq" and "sortstring." These files are created on a work diskette. Because the work files will eventually consist of all of the records in the original file, it is necessary to have two disk drives if there are more than approximately 600 records in each file. Otherwise, you will run out of disk space in the middle of the sort/merge.

In running the sort and merge programs, you must first specify the input file to the program. The input file is the original file (in my example, PCFMEMBERS). Next the program asks for the record string delimiter. Just hitting return enters the default value of hex "FF."

That done, the program asks for the record length. The response must be the length of the longest record. That information is used to determine how many records can be held in the internal memory of the computer at any one time. Next you must enter the key location, length and sequence. When sorting PCFMEMBERS by zip code I merely respond with "123,7,A." That tells the program that the field to be sorted, the zip field, begins at character location number 123, is seven characters long and is to be sorted in ascending order. The zip field is seven characters long to accommodate members with Canadian zip codes.

I should note that when entering zip codes you must be sure to enter the numeric character 1 rather than the lowercase L for a one. The ASCII values of the numeric one and the lowercase L are different, and a zip sort won't work if a lowercase L is entered (that comes from painful experience).

After you enter the data for key number one, the program asks for the same data for key number two. If there is to be a sort by only one key field, a

return sets the sort program into action. It tells you how many records are to be sorted, the number of records per substring and the number of substrings if the number of records is greater than the number that will fit into memory at any one time. The program then asks for the sort work file drive number and the name of the output file.

As indicated before, the name of the input file in my example is PCFMEMBERS (the original master file), and the name of the output file in the example is PCFZIP. It presently takes me approximately an hour and a half to do a full sort and merge on PCFMEMBERS.

Conclusion

I have given a brief overview of the concepts involved in data base management and a description of the specific data management program I am using. I have found the data base management system program the most useful program that I have (with the possible exception of my word-processing program). The documentation that comes with the program is a little confusing the first time through. However, when you sit in front of the computer and run the program, the documentation becomes fairly easy to follow. Some of the program's nuances were lost on me until I had gained some experience working with it.

One thing I have learned in dealing with data base management is that you must (and I can't emphasize it enough) maintain backup diskettes for every data base. You should update the backup every time the master is updated. And if you ever find it necessary to use the backup diskette, always hardware-protect the backup disk and make a backup for the backup before actually using the backup. You may have put hundreds and hundreds of hours into creating the data base; the computer can totally destroy all that work in seconds, so be very, very careful. ■

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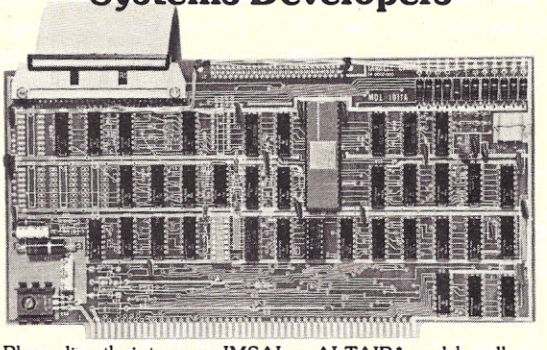
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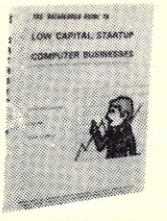
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Learn with Me:
Analog and Digital Interfaces

This two-part article concludes with some practical applications of the knowledge that was presented in the first part, which appeared in the March 1979 issue on page 40.

Rod Hallen
Road Runner Ranch
PO Box 73
Tombstone AZ 85638

In Part 1 we took a look at the theory of analog-to-digital and digital-to-analog conversions. We also discussed this theory as it applies to an actual computer product (the Cromemco D+7A I/O interface board). Now it's time to use that knowledge for some practical purposes.

Applications

The parallel input port. Before we get to the practical applications of the DAC and ADC portions of the D+7, let's look briefly at the parallel ports and see what they can do for us. Many of the earlier microprocessors, such as the Altair and the Imsai, had a front panel filled with switches to enter data. It was possible, in fact, in many cases necessary, to load programs with these switches. Anyone who programs with a keyboard certainly wouldn't want to go back to toggling in long program listings, but data switches do have their uses.

Suppose you wanted to change some operating condition within a program while it was running without having to stop it. If you had a set of eight switches wired as in Figs. 1a or 1b and had them connected to a parallel input port, the program could be directed to read that port before it made various decisions.

My SOL has an eight-position DIP (double in-line package) switch, called a sense switch, mounted on the CPU board and wired to input port 255. Unfortunately, the CPU board is enclosed in a rack mount, and I don't have access to these switches. So I wired up Fig. 1a on my control panel and connected it to the D+7 parallel input port that is addressed at port 24. I now have direct access to the data bus.

As an illustration of one use of these sense switches, let's control the data output of my computer. The SOL outputs all data to the video screen unless I tell it from the keyboard to send it to some other port. If I

```
100 REM-SET OUTPUT PORT WITH SENSE SWITCHES
110 LET X=INP(24)
120 SET OP=X
```

Program A. Data output routine. This simple program causes my SOL to read the sense switches and then to direct the output accordingly. OP = 0 is the video screen, OP = 1 is the serial port (Teletype), OP = 2 is the parallel port (Selectric) and OP = 3 is a custom port. In order for this to work, the remaining sense switches must be off (low). It is also possible to combine this program with Fig. 2 and Program B to allow all of the switches to have a function.

```
 10 REM-ROUTINE TO READ CONTACT CLOSURES ON A PARALLEL PORT
 20 REM-ROD HALLEN  TOMBSTONE, AZ  21 JUNE 1978
 30 SET OP=1
 40 FOR I=1 TO 1000
 50   LET X=INP(24)
 60   IF X=0 THEN  PRINT "ALL'S WELL": GOTO 150
 70   IF X>127 THEN  PRINT "THE HOUSE IS ON FIRE": LET X=X-128
 80   IF X>63 THEN  PRINT "THERE IS A BURGLAR IN THE KITCHEN": LET X=X-64
 90   IF X>31 THEN  PRINT "THE SOLAR SYSTEM IS TOO HOT": LET X=X-32
100   IF X>15 THEN  PRINT "THE SOLAR SYSTEM IS TOO COLD": LET X=X-16
110   IF X>7 THEN  PRINT "THE uP POWER SUPPLY IS TOO HOT": LET X=X-8
120   IF X>3 THEN  PRINT "THE POWER HAS FAILED": LET X=X-4
130   IF X>1 THEN  PRINT "THE SUN IS UP": LET X=X-2
140   IF X=1 THEN  PRINT "THE GARAGE LIGHT IS ON"
150   PAUSE 50
160 NEXT I
170 SET OP=0
180 END
```

Program B. This routine reads a parallel input port and prints messages according to which data lines are high. Use this in conjunction with Figs. 1 or 2. Instead of, or in addition to, printing messages, subroutines could be called to ring an alarm, turn equipment on or off or take other appropriate action.

place a subroutine (Program A) within a program, using the sense switches, I have direct control over where the output goes while the program is running. When both S1 and S2 are off, the output goes to the screen; S1 turned on sends it to my Model 43 Teletype; S2 turned on sends it to my Selectric; and both switches turned on send it to any other port I care to designate.

This is only one example. How about setting the difficulty of a game with the switches or deciding whether your business program will print out a part or all of a given report? These switches could be limit switches to indicate damper position in a furnace, valve operation or door and window security switches. The possibilities are endless. The program reads the switches and makes a decision accordingly.

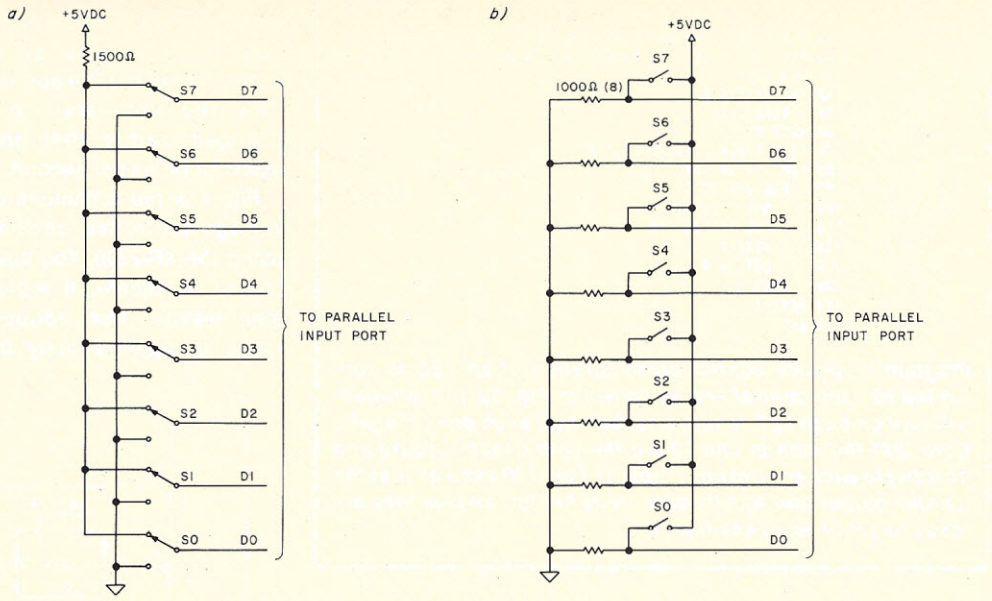


Fig. 1. Wiring sense switches to a parallel input port. They are called sense switches because the processor senses their condition and makes decisions accordingly. The figures show two different ways of achieving the same results. Fig. 1b uses less expensive switches but more resistors.

Another possibility is to connect relay contacts from various devices to these parallel input data lines instead of switches, so whenever the port is read the processor will be aware of various external events. There would normally be ground through a pull-down resistor on the data line, but when the relay operated, it would raise the line high to +5 volts. These relays could be part of a fire or burglar alarm system, a solar energy heating and cooling system or just about anything that you wanted to monitor. See Fig. 2 and Program B.

The parallel output port. The parallel output port can be used to control external devices. Fig. 3a is a diagram of a circuit that will control eight different devices. With the addition of demultiplexers (such as the 74154) up to 256 different relays or devices could be handled by one output port.

Each D flip-flop (½ of a 7474) is set (device or relay operated) or reset (device non-operate) by a low-to-high transition on its C lead. Every time the C lead goes high, the flip-flop will reverse its output. That is why they are called flip-flops. Program statement OUT 24, 1 (output a binary 00000001 to port 24) would turn on device number 1; OUT 24,4 (output binary 00000100) would turn on device number 3; and OUT 24,128 (binary 10000000) would turn on device number 8. See Table 1.

However, you can't program statement OUT 24,1 to turn on device 1 and immediately repeat the statement to turn it off. When you OUT 24,1 the first time, data line 0 will go high, IC1A will set and device 1 will be turned on. Since the D+7 parallel output port is a latched port, data line 1 will remain high; it can't go from low to high on your next OUT 24,1 command since it is already high.

The solution to this problem is to OUT 24,0 after each required OUT command. This will unlatch the output port and set all data lines low. However, device 1 will stay on since IC1A will stay set until the next OUT 24,1 raises data line one from low to high again, resets IC1A and turns device 1 off. See Program C.

In most cases the control lines from the flip-flops can't control too many devices directly. They just can't handle the current or the voltage. Fig. 3b shows one instance where this is not so. The control lines can work directly with LEDs

Binary Value	Decimal Value	Device #
00000001	1	1
00000010	2	2
00000100	4	3
00001000	8	4
00010000	16	5
00100000	32	6
01000000	64	7
10000000	128	8

Table 1. The conversion from binary or decimal value to device number. For example, sending a 16 to the device control parallel output port would reverse the condition of device control line 5.

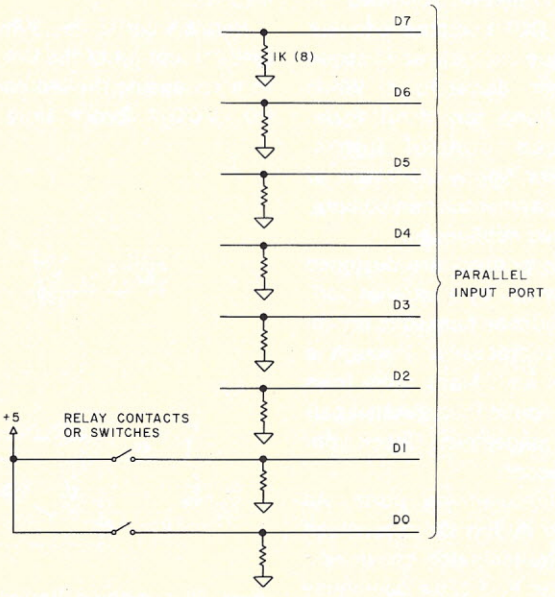


Fig. 2. This is similar to Fig. 1 except that external relay contacts or switches are used. These can be in heating and cooling systems, fire and burglar alarms, moisture detectors or anything else that needs to be monitored.

```
10 REM-DEVICE CONTROL DEMONSTRATION
20 REM-ROD HALLEN  TOMBSTONE, AZ  6 JUL 78
30 DIM X(8)
40 FOR K=1 TO 8
50   READ X(K)
60 NEXT K
70 DATA 1,2,4,8,16,32,64,128
80 FOR I=1 TO 100
90   FOR J=1 TO 8
100    OUT 24,X(J)
110    FOR T=1 TO 300
120    NEXT T
130    OUT 24,0
140  NEXT J
150 NEXT I
160 END
```

Program C. Device control demonstration. If an LED is connected to each control line as shown in Fig. 3b, this program will turn on each LED in turn and then turn each one off again. Note that the data in line 70 are the codes that activate and deactivate each control line (Table 1). Line 130 assures that the parallel output port has its data leads set low so that they are ready to set or reset any flip-flop.

(light-emitting diodes) and TTL (transistor-transistor logic) ICs.

Normally, we'd use the control lines to activate driver circuits, which, in turn, would switch the heavier loads. Figs. 3c, 3d and 3e are three driver circuits. Triacs, which will handle up to 20 Amps at 120 volts ac, can be purchased for under $3.

Now that you can control external devices, which devices would you want to control? How about your printer? Instead of having it run all of the time or having to manually turn it on and off, why not connect it to one of your device control ports? Whenever you need the printer, OUT a command to turn it on, loop until it is up to speed and then dump to it. When you're done, turn it off again. You can control lights, recorders, floppy disks and, of course, numerous non-computer-related appliances.

Some printers are designed to be driven by a parallel port. Data could be passed to another microprocessor through a parallel port. Many other uses can be found for a parallel port in the magazines. Check your back issues.

Digital-to-analog ports. As we saw during the discussion of digital-to-analog conversion theory in Part 1, we can cause the D/A port to put out any voltage we desire (within the range of the converter, of course). We can hold this voltage steady or we can change it as often and as rapidly as we want. If we changed it from −2.56 to +2.54 and back again, one thousand times per second, we would have a 5 volt peak-to-peak 1000 Hz square wave. If we connected this to a speaker, we'd have a 1000 Hz tone.

Changing the frequency at which the voltage was reversed would, in turn, change the tone. In effect, we would have sound capability. Some computer music systems operate in just this way. However, this is a fairly difficult system to implement because of the programming involved.

Here's a better way. Why not feed the output of the D/A port to a voltage-controlled oscillator (VCO)? Every time the voltage changed, the tone would change. It would only be necessary to change the voltage out of the D/A port each time the note was to be changed, rather than thousands of times per second.

Fig. 4 is the schematic of a voltage-controlled oscillator using the XR-2206. You have a choice of square, triangle or sine waves. The frequency range is approximately 0 to 4500 Hz with the part values shown, although the 2206 will go to 1 MHz with the proper components. This could also be used as a programmable signal generator. The MC4024 dual VCO is another candidate for this service.

Program D is for demonstration purposes and will cycle the output of the XR-2206, with a small speaker connected to one of its outputs, through its

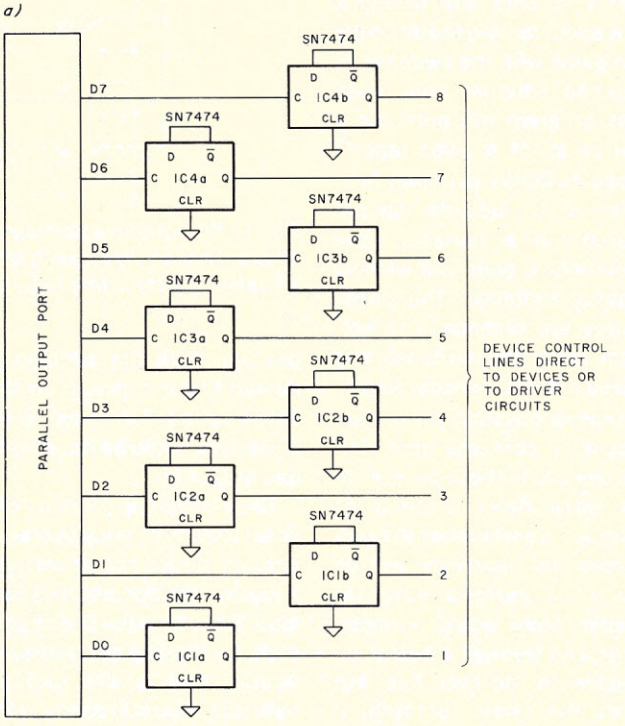
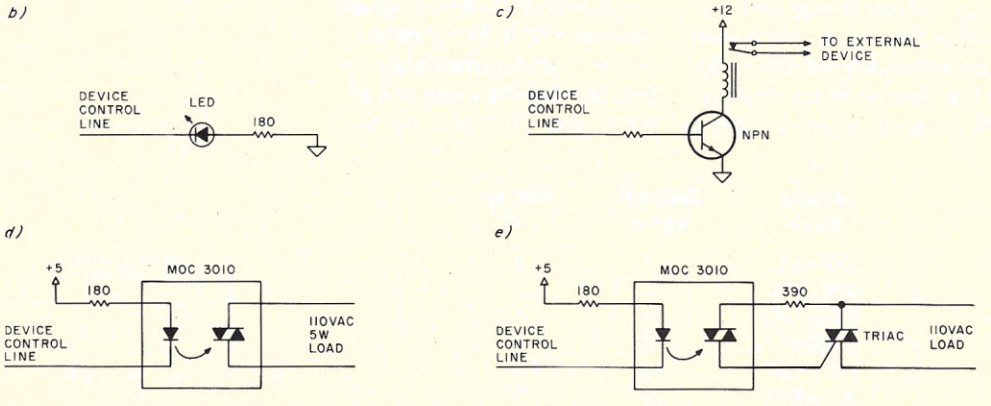


Fig. 3a. External device control. Each data lead from the parallel output port will control one flip-flop, which, in turn, will control one external device. Each time the C lead of a flip-flop is raised from low to high, its output will change. If the output is low it will go high and vice versa. Normally, these control lines will not be able to handle the external devices directly.



Figs. 3b, c, d and e. Various methods of using the TTL output of the flip-flops to drive relays or triacs. 3b will handle low-current requirements such as TTL counters and LEDs. 3c uses a transistor to increase drive capabilities. 3d uses an MOC3010 opto-isolated triac driver to switch ac loads up to 5 Watts. 3e utilizes a triac for heavy-duty switching. Triacs will switch ac only and are available for loads up to 2000 Watts or more.

```
10 REM-SWEEP FREQUENCY GENERATOR
20 REM-ROD HALLEN  TOMBSTONE, AZ  6 JUL 78
30 FOR I=1 TO 10
40   FOR J=127 TO 0 STEP -1
50     OUT 25,J
60     GOSUB 140
70   NEXT J
80   FOR J=255 TO 128 STEP -1
90     OUT 25,J
100    GOSUB 140
110  NEXT J
120 NEXT I
130 END
140 FOR M=1 TO 250
150 NEXT M
160 RETURN
```

Program D. Used with Fig. 4, this routine will step the XR-2206 function generator from 0 to about 4500 Hz. A small speaker should be connected from 2206 pins 2 or 11 to ground.

frequency range to give you some idea of the possibilities. This is really a simple form of sweep frequency generator.

Fig. 5 shows an interface between two D/A ports and an oscilloscope. Port 1 will control the horizontal position of the trace on the scope screen, and port 2 will determine the vertical position. By changing both port values rapidly in a systematic manner, production of pictures is possible. This is a graphics capability far exceeding that possible with the normal computer CRT terminal. Program E should draw a square by moving the trace continually around the perimeter of the screen. The actual voltages required by any given scope will vary, and some attenuation may be necessary.

This same interface could be used to drive a plotter for hard-copy charts and graphs. It could also cause a chart recorder to give us a running readout of one or more parameters. A continuous temperature, pressure or light plot would be useful in many situations.

The D/A ports can come into play anytime you need a variable voltage for any reason. Motor speed, temperature and light control are just a few of the many situations where this is true.

Analog-to-digital ports. OK. Now let's put those analog-to-digital ports to work. We've learned that if we apply a voltage in the range from +2.54 to −2.56 to one of our A/D ports, the D+7 will convert this voltage to a digital value and the computer will be able to

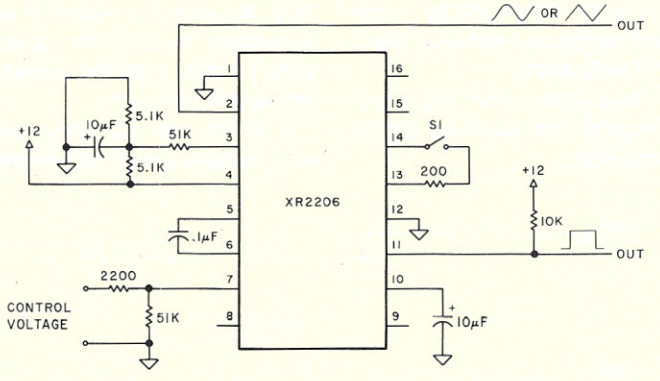


Fig. 4. Programmable function generator. The frequency range is determined by the capacitor bridged across pins 5 and 6. The frequency output within this range is controlled by the voltage at pin 7. The output from pin 2 will be a sine wave with S1 closed and a triangle wave with S1 open. The 2206 is also easily configured as a two-tone RTTY or landline data transmitter. Another possibility is the Motorola MC4024, which contains two VCOs on one chip at a very reasonable price.

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```
10 REM-SCOPE SKETCHER
20 REM-ROD HALLEN  TOMBSTONE, AZ 15 JUL 78
30 FOR I=1 TO 1000
40   LET X=0: LET Y=127
50   OUT 25,X: OUT 26,Y
60   LET X=127
70   OUT 25,X: OUT 26,Y
80   LET Y=128
90   OUT 25,X: OUT 26,Y
100  LET X=0
110  OUT 25,X: OUT 26,Y
120 NEXT I
130 END
```

Program E. This is intended to draw on an oscilloscope screen using Fig. 5. Experimentation will probably be required to make the D/A ports compatible with your scope. Once this is working, various values, formulas, etc., can be used to generate complex graphics.

read it. We've also learned that this by itself makes for an accurate voltmeter. However, its use will be limited because we often have a need to measure voltages of a much greater amplitude than ±2.5.

Using a resistive voltage dividing network, we can extend the range of our voltmeter as much as we want. Fig. 6 is a multirange digital voltmeter for use with one of our D+7 A/D ports. The voltage divider consists of resistors R1, R2 and R3.

With the switch (S1) in position 1, our range will be the same (+2.54 to −2.56) as it was originally and our readout will be in .02 volt steps. If we move S1 to its second position (between R1 and R2), then our range will increase by a multiple of 10 (+25.4 to −25.6) and our readout will be in .2 volt steps. S1 in position 3 (between R2 and R3) will multiply the range by 100 (+254 to −256) and our readout will be in steps of 2 volts each.

Here are some important things to note about our digital voltmeter.

1. The decimal readout (2^8 or 1 part in 256) is determined by the number of bits in our digital byte. If we had a 16 bit A/D converter, we'd have the possibility of a readout of 1 part in 65,535 ($2^{16} = 65{,}535$).

2. The overall accuracy of this DVM depends on many factors. Low tolerance (1%) resistors should be used for R1, R2 and R3, the D+7 should be calibrated according to the manual and that calibration should be checked regularly.

3. Program F will print three values, and the correct one will be determined by the position of our range switch (S1). For instance, if we are measuring a voltage, the range switch is in position 2, and the computer prints:

Position 1	Position 2	Position 3
1.65 V dc	16.5 V dc	165 V dc

then the voltage is actually 16.5. As with any meter it is necessary to set the range switch higher than the voltage we want to measure.

4. Since the A/D converter will automatically determine

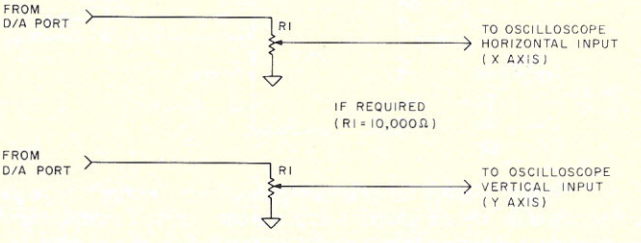


Fig. 5. Interface between two D/A ports and an oscilloscope. Variations in the two voltages will move the trace on the scope screen. Most scopes incorporate some kind of variable input attenuation, but the pots (R1 & R2) may be required to reduce the signal level. This could also feed an X-Y plotter or chart recorder.

✓ Reader Service—see page 179

```
10 REM-VOLTMETER READER FOR CROMEMCO D+7A I/O BOARD
20 REM-ROD HALLEN  TOMBSTONE, AZ   18 MAY 1978
30 FOR I=1 TO 100
40   LET X=INP(27)
50   IF X>127 THEN 80
60   LET E=X*.02
70   GOTO 90
80   LET E=(255-X)*-.02
90   PRINT CHR(11)
100  PRINT TAB(7);"POSITION 1";TAB(25);"POSITION 2";TAB(43);"POSITION 3"
110  PRINT
120  PRINT TAB(7);E;" VDC";TAB(25);E*10;" VDC";TAB(43);E*100;" VDC"
130  FOR T=1 TO 600
140  NEXT T
150 NEXT I
160 END
```

Program F. Our digital voltmeter interpreter. Line 50 is looking for negative voltages (lines 128 to 255 indicate negative), line 90 clears the screen and homes the cursor and lines 130-140 represent a one-second delay. Reduce the value of the T loop for a shorter interval between readings.

```
51 LET X=INP(27)
52 IF X<128 THEN 55
53 LET K=INT((X-128)*7.88)/10
54 GOTO 60
55 LET K=INT(X*7.88)/10+100
```

Program G. In my Lunar Lander game line 50 says: INPUT K, which is the burn rate. By replacing line 50 with this program, I can input the burn rate from a throttle or joystick. If things happen too quickly, put a pause or delay in line 50. While the formulas in lines 53 and 55 look complicated, they are written that way so that they will only print one place after the decimal point. They could be written: line 53 LET K = (X – 128).79 and line 55 LET K = X*.79 + 100.*

whether a voltage is positive or negative, it is not necessary to reverse the meter leads when measuring negative values. The ground (black) lead should always go to an electrical ground in the circuit being tested.

Our digital voltmeter can also be used to measure current flow as any other meter. If we put the leads across a 100 Ohm resistor and read 10 volts, then we know that 100 mA of current is flowing because Ohm's law says that voltage divided by resistance equals current (10/100 = .100 Amp or 100 mA).

Suppose, instead of measuring an unknown voltage, we connect one of our A/D ports to the wiper on a potentiometer (variable resistor) that is tied across a ±5 volt supply as in Fig. 7a. By turning the shaft of the pot, we can cause the A/D port (and the computer) to see any value between +2.54 and −2.56 volts.

This can have many uses. For example, almost every computer hobbyist has at one time or another played Lunar Lander. You simulate a landing on the moon by entering burn rates from the keyboard. The particular version of Lunar Lander that I have calls for an INPUT K (K is the burn rate from 0 to 200 pounds of fuel per second) and then uses K in the equation that determines how fast the lander descends.

Program G uses a different approach that should allow it to fit into just about any version of the game. Instead of looking to the keyboard for a burn rate entry, this program reads the pot connected to A/D port 3 (I/O port 27) and determines the burn rate from that. Note that the program reads the A/D port, figures your burn rate, which is used by the rest of the game program to calculate your rate of descent, and then goes back for a new A/D input.

Except for a short pause due to the mathematical calculations, it runs continually without giving you much time to read and absorb the results of the last input. This is similar to the situation in an actual lander and gives the game a much more realistic feeling. If desired, a longer pause can be added in line 50. Without it, things happen very quickly indeed!

I mounted R2 of Fig. 7a in the side of a small chassis, put a large knob on it and screwed the end of a four-inch plastic rod to the face of the knob. I use this "throttle" for the above real-time Lunar Lander, but it can be used in any situation where it is desirable to be able to provide a hand variable input to a program. The +5 and −5 volts are provided by the D+7 board, but they can be tapped off of your computer power supply. Fig. 7a also shows how to use ±12 instead of ±5 if it is more readily available. The throttle does not represent much of a power supply load since it draws little current.

There are many joysticks on the market that could be used in place of the throttle. A joystick is a lever that can be moved front to back, side to side and anywhere in between. The lever is connected to either two or four potentiometers so that it is always possible to determine the exact position of the lever by reading the resistance of these pots. See Fig. 7b for a joystick schematic.

Fig. 8 shows how the joystick position compares to the resistance of R5 and R8 in Fig. 7b. With the lever in the midposition, pots R5 and R8 both measure 5000 Ohms since they

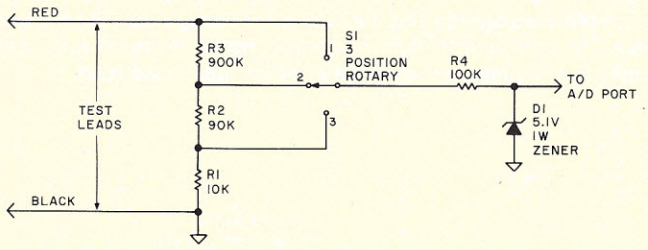


Fig. 6. Digital voltmeter. R4 and D1 protect the A/D port from excessive voltage, for example, if you tried to measure 200 volts with the range switch on position 1. R1, R2 and R3 should be 1 percent tolerance for best accuracy.

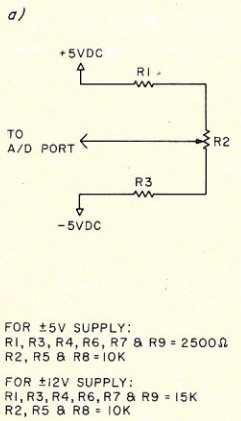


Fig. 7a. The "Throttle." The value of the pot (R2) is not critical, but R1 and R3 should retain the same ratio to it. If R2 equaled 50,000 Ohms, then R1 and R3 should be increased 5 times also. Five percent or 10 percent resistors can be used. Values are also given for a ±12 volt supply.

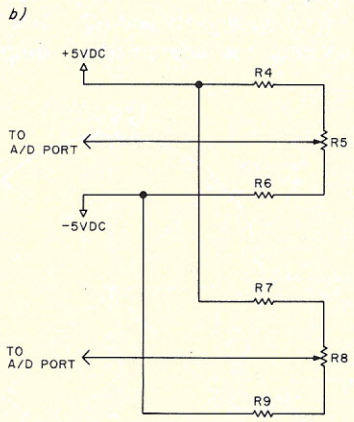


Fig. 7b. The joystick has two pots connected to a single lever. One pot tracks the front-to-back position of the lever, and the other tracks the side-to-side position. The joystick can be used for input to games, graphics or other situations where a continuously variable two-dimensional input is needed.

```
10 REM-LIGHT SENSOR FOR D+7 I/O
20 REM-ROD HALLEN  TOMBSTONE, AZ  15 MAY 78
30 FOR I=1 TO 1000
40   LET X=INP(27)
50   IF X>127 THEN  LET X=1
60   IF Y=1 THEN 80
70   IF X<40 THEN  PRINT "THE LIGHT IS OFF": LET Y=1: GOTO 120
80   IF Y=2 THEN  GOTO 100
90   IF X>39 AND X<80 THEN  PRINT "THE LIGHT IS DIM": LET Y=2: GOTO 120
100  IF Y=3 THEN  GOTO 120
110  IF X>79 THEN  PRINT "THE LIGHT IS BRIGHT": LET Y=3
120 NEXT I
130 END
```

Program H. The photocell reader. Using Fig. 9, this will give a readout of the light falling on the photocell. Y = 1,2 or 3 eliminates multiple printing. As long as light conditions don't change, the last statement printed is the current condition.

are both at midrange. With the lever pushed away from you (12 o'clock position), R5 reads 10,000 Ohms, but R8 still reads 5000 Ohms. Pulling the stick directly towards you (6 o'clock position) will cause R5 to change to 0 Ohms while R8 still reads 5000 Ohms. Now we know that R5 indicates the Y axis, or front to back.

R8 didn't change while the stick was moving front to back because R8 indicates the X axis, or side to side movement. Take the lever to the 9 o'clock position; R5 will read 5000 Ohms and R8 will measure 0. The 3 o'clock position will mean R5 equal to 5000 Ohms and R8 equal to 10,000 Ohms. Of course, if the lever is pushed to some other position, partway to the two o'clock position, for example, we can find that position by reading R5 and R8 and plotting the coordinates from that information. In this case R5 equals 8000 Ohms and R8 equals 9000 Ohms.

Light and temperature detection. What else can we use an A/D port for? We can detect the presence or absence of light or determine temperature. Fig. 9 is a simple light sensor, and Program H reads light values. A cadmium sulphide photocell has a high resistance in the dark and a low resistance in bright light. The resistor (R) is chosen so that the A/D port sees 0 volts when the photocell is in complete darkness and +2.5 volts when it is in a bright light. Trial and error (or a potentiometer) will determine the value of R, which is dependent upon the photocell you use.

Program H reads the photocell and then prints, "THE LIGHT IS OFF," "THE LIGHT IS DIM" or "THE LIGHT IS ON," depending upon what the photocell sees. At first this may seem a little silly and of no purpose, but this is just to demonstrate the potential. The photocell could be sensing outside light, checking the flame in a gas furnace, keeping tabs on an automated photographic processing system or used anytime it is necessary to keep track of the level of light. Program H divides the input into three categories, but in actuality we can read 256 different levels.

Temperature can be measured in the same manner (see Fig. 10). A thermistor increases its resistance as its temperature rises. R is selected so that the highest desired temperature provides 0 volts to the A/D port and the lowest temperature applies +2.5 volts. See the spec sheet on the LM3911 linear integrated circuit for another inexpensive easily scaled temperature detector.

With a thermistor outdoors connected to one A/D port and another indoors connected to a second port, it would be possible to track the difference between the two temperatures. You should be able to tell something about the efficiency of your home insulation by taking measurements over a period of time (say 24 hours) without either the furnace or air conditioner running. This is a very rough theory, but the more slowly the inside temperature follows changes in the outside temperature, the better your insulation is.

The photocell in Fig. 9 or the thermistor in Fig. 10 could be replaced by a pressure transducer, microphone or any other kind of a sensor or circuit that can provide a voltage between +2.54 and −2.56 volts. This voltage would then be used as input data by a program written to translate it into usable terms. If you used a voltage divider or an amplifier between the sensor and the A/D port, much higher or lower voltage ranges could be handled.

Conclusion

Digital-to-analog conversion, analog-to-digital conversion, parallel input ports and parallel output ports have been discussed from the theory, hardware and practical-applications point of view. If any of this isn't clear, go back and reread both Part 1 and Part 2. It is really to your benefit to do so.

This is the end of this article but it is just the beginning of the possibilities that digital and analog interfaces open up to the computer hobbyist. Any device that utilizes heat, light, pressure or electrical signals is a candidate for interface to your computer. I guess that includes just about everything. Once you get tired of computer games, simulations and other programs where your eyes and fingers are the only connection that your computer has with its surroundings, try interfacing to the real world. That is what personal computing is all about. ■

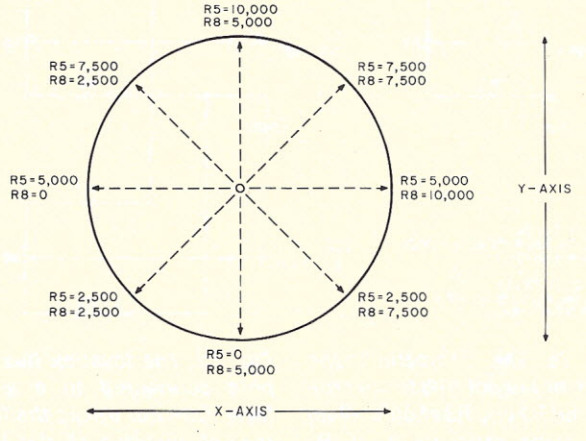


Fig. 8. Overhead view of the joystick. The pots (R5 and R8 of Fig. 7b) would each measure 5000 Ohms with the lever at midposition. A program could be written to determine the exact position at any time by reading the two pots. The output of this program could be used as input to a music synthesizer, graphics display generator, game or whatever.

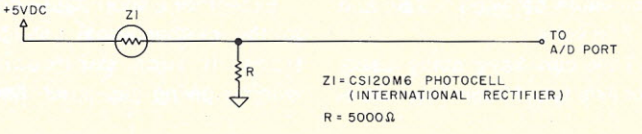


Fig. 9. The light sensor. The amount of light falling on the photocell will vary its resistance and, therefore, the voltage that the A/D port sees. No light equals high resistance, which means 0 volts, and bright light equals low resistance, which means 2.5 volts.

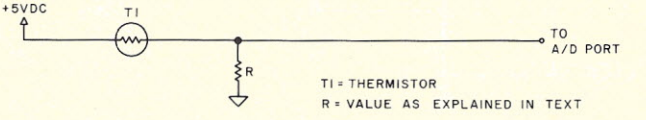
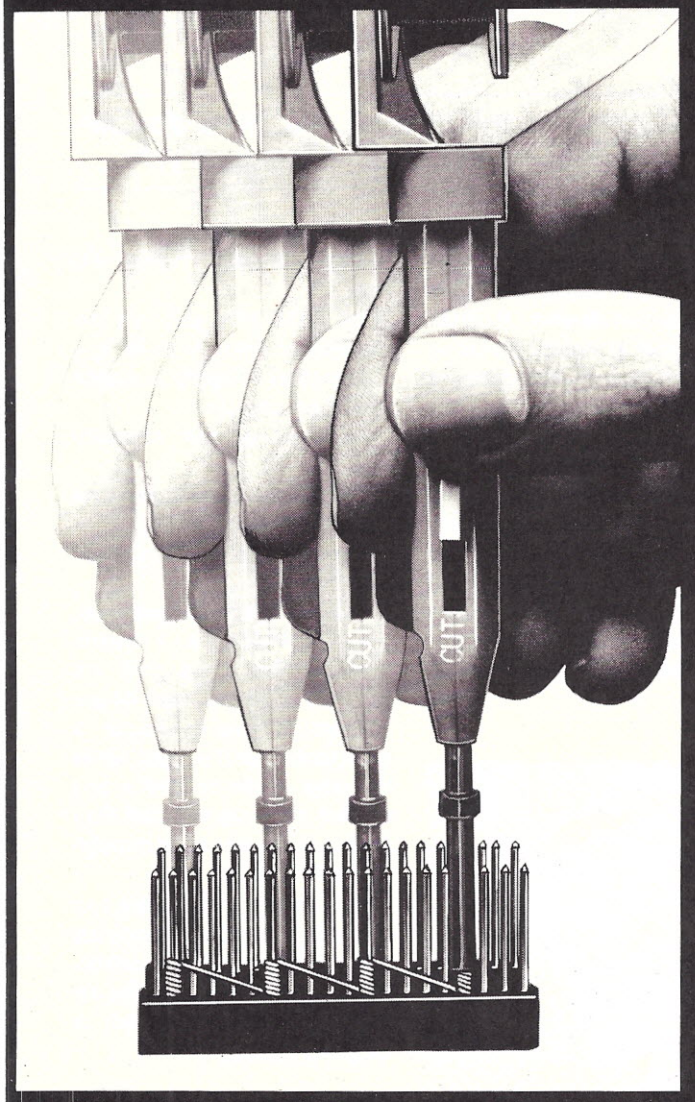
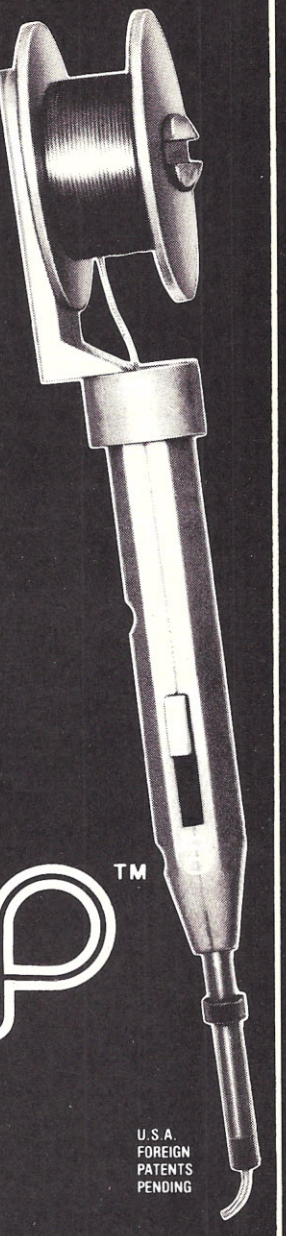


Fig. 10. The temperature sensor. The thermistor works just the opposite of the photocell. Its resistance increases as the temperature increases. One of these planted in your computer power supply would give warning of excess temperatures.

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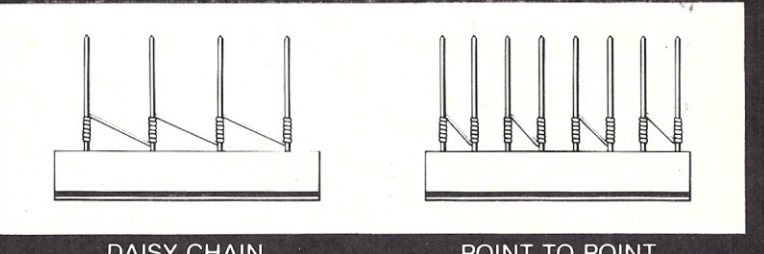
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COSMAC Double Play

When two views of the COSMAC VIP arrived in the same batch of mail, we did a double-take, then decided both of them warranted publication. Here they are: La Dolce VIP . . .

Larry Dolce
2 Mayfield St.
Valley Cottage NY 10989

I had been looking for an inexpensive entry into personal home computing. After much soul-searching, I came up with the following requirements for selecting a micro:

1. Cost: A major factor because I was unable to justify a large expenditure (over $200) to myself and my wife.

2. Fun: Since I am a data-processing professional working in business applications, I did not want my home computer to be an extension of my work. My own system would be just for fun.

3. Kit: The unit I purchase must come in a kit version. Being a masochist, I felt it necessary to assemble my own unit so I could receive a sense of accomplishment in seeing *my* computer work.

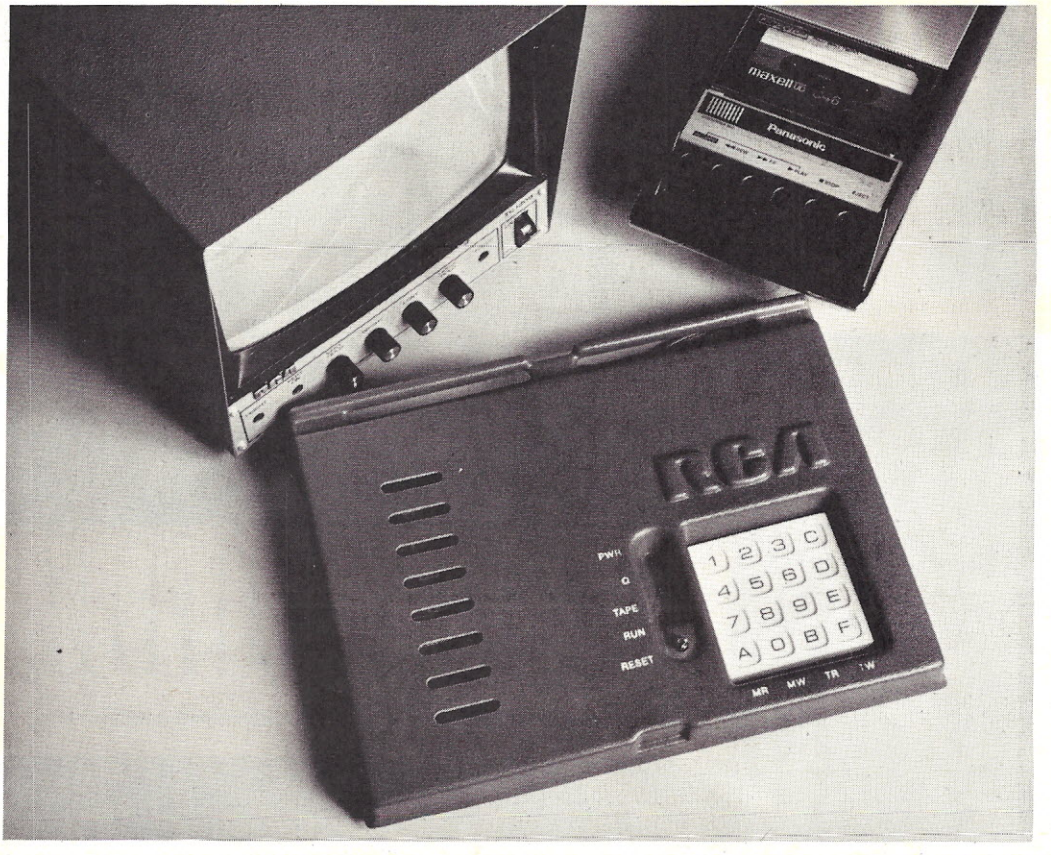
4. Available Games: The unit I buy must have games available to play immediately since I never know when I will ever write my own. Anyway, it usually is easier to modify someone else's program to do something different than to try to create a new game.

When RCA lowered the price on their COSMAC VIP, I could no longer find any excuses not to buy. So, as a result of a trip to my local computer store with my bank charge card, I now own a VIP kit. Some of the hardware features of the VIP are as follows:

- Single 8 1/2 × 11 inch PC card.
- 2K RAM with on-board expansion of memory to 4K (my kit contained readily available 2114 RAM chips).
- On-board graphic capabilities.
- 100 byte-per-second cassette interface (a must).
- 512-byte operating system on ROM.

The expansion capabilities, which I did not list as a requirement but are a big plus, are planned through two 44-pin connectors. One connector is used as a parallel I/O port, while the other 44-pin connector has all the 1802 signals and flag lines that can be tested through program control.

Contained in the kit are two manuals: the 1802 user manual and the COSMAC VIP instruction manual, containing the assembly instructions as well as 20 game listings.



COSMAC VIP assembled with the cover in place. *(Photo courtesy of RCA)*

Construction of the VIP Kit

My first glance at the kit indicated clear-cut assembly. RCA supplied seven sockets for the key chips. I elected to use sockets for all the ICs. This required the additional purchase of one 8-pin socket, one 24-pin socket, five 14-pin sockets and five 16-pin sockets. (These additional sockets do not apply to the on-board expansion options. The options require even more sockets.) When examining the parts against the parts lists in the manual, I found one 4013 (two in the parts list) and one 4011 (none in the list). I also found four 2114 memory chips



The COSMAC VIP kit comes with the bare board and all parts supplied, including the VIP instruction manual and the user manual for the CDP 1802 COSMAC microprocessor.

instead of the RCA 9131 RAMs mentioned in the parts list. The 2114 memory I ruled as substitution and the 4011 I assumed was a packing mistake. Never assume anything in data processing. Anyway, my junk box contained a 4013, and I was using all sockets, so I proceeded to build the kit without first checking with RCA.

In constructing my VIP kit, I made two mistakes with resistors. I soldered a 10k Ohm resistor in place of a 22k Ohm resistor and I soldered a 200 Ohm resistor (red-black-brown) in place of a 1000 Ohm resistor (black-brown-red). You must be *careful* when identifying resistors by color as RCA offers no other identification except the color band.

After soldering all discrete components and sockets in place (watch the board for the white dot where pin 1 goes), I carefully inserted all ICs into their sockets. This included the 4013 in place of the 4011 supplied with the kit. When I plugged in the power supply that came with the kit, the speaker sounded a continuous tone. Something was wrong. I double-checked all the parts for correct placement and checked the board for solder bridges, but found none. The printed circuit board was well made, and I did not believe there would be any solder bridges.

All work on the VIP halted until Monday morning when I could call RCA. RCA helpfully listed a telephone number for technical assistance on their warranty card, which also mentioned a $30 charge to repair the kit if they felt you were at fault in the assembly.

In my conversation with RCA, I was told that the 4011, which I assumed was packed in error, did, in fact, belong with the kit. The VIP instruction manual included with my kit was not the correct one for this version of the VIP kit. It turned out that RCA had *two* versions of the VIP: one with 2114 memory and the other with 9131 RAM chips. The 2114 version required a 4011 gate, whereas the 9131 version required a 4013 flip-flop.

The final outcome of my assembly problems was that I needed a new 1802 CPU chip, since the one supplied did not function even after I placed the 4011 in the proper socket (thank goodness I used all sockets). Fortunately, I had been able to substitute a good 1802 CPU for the one supplied (I have a well-stocked junk box). The alternative would have been to send the entire unit back to RCA for testing. I would advise anyone doing this assembly to be very careful when inserting the chips in their sockets. RCA will consider bent pins as an assembly fault requiring them to charge you for the repair. I returned the 1802 microprocessor chip to RCA and am awaiting a new one along with the proper version of the manual—no charge.

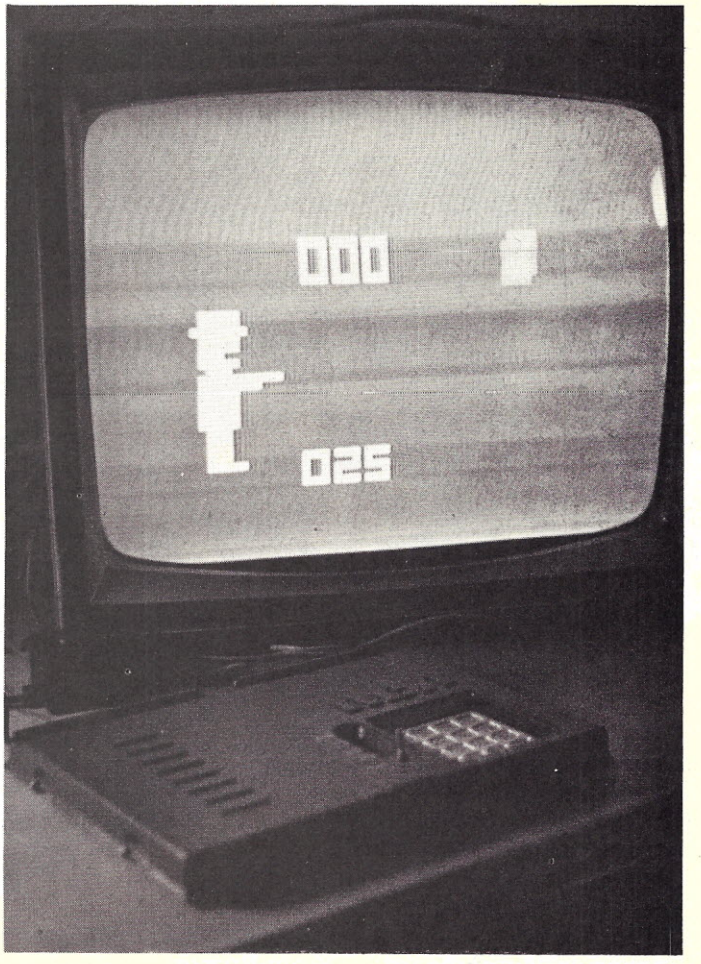
Operation of the VIP

The RCA COSMAC VIP contains no LED readouts, so all output must be displayed on either a video monitor or a TV set via an rf modulator. I find this to be an excellent alternative to a front panel even though it requires additional programming. The video display gives the impression of sophistication.

The operating system supplied on ROM is entered by depressing the C key on the hex keypad while switching the run/reset switch to the run position. This causes a hardware jump to address 8000 (hex). This jump leaves all memory locations from 0000 (hex) intact. When entered, the operating system turns on the video display so that any one of the four functions (memory read, memory write, cassette read and cassette write) will have the starting address displayed on the screen and the byte contained at that address (for memory read and write only).

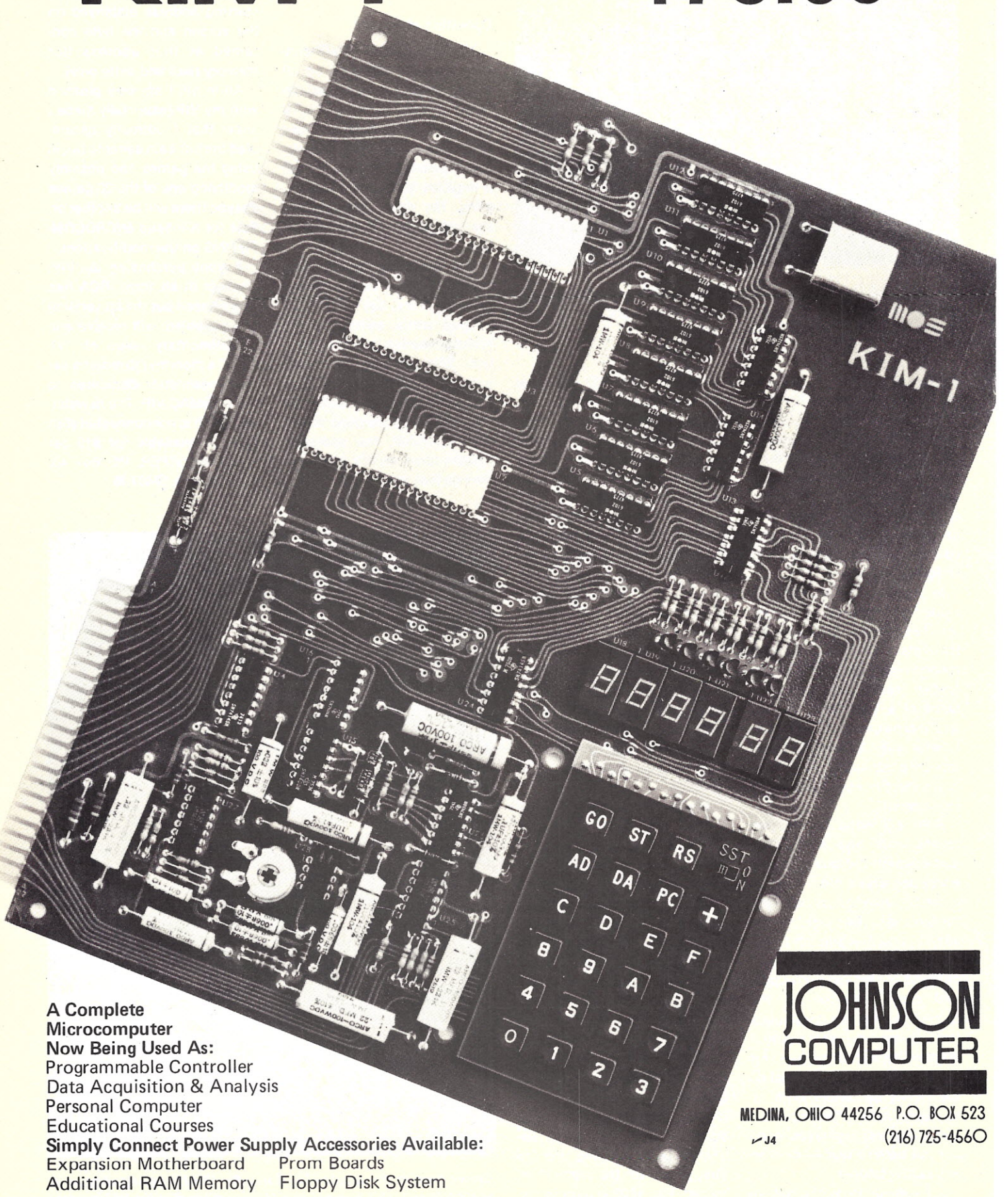
All in all, I am very pleased with my VIP (especially since I know that I correctly assembled the kit). I am eager to begin using the games and possibly modifying one of the 20 games (maybe there will be another article for *Kilobaud MICROCOMPUTING* on the modification).

Anyone purchasing the VIP, whether in kit form (RCA has now phased out the kit version) or assembled, will receive one complimentary issue of "VIPER," a monthly (10 months per year) newsletter dedicated to the COSMAC VIP. The newsletter, which is not connected with RCA, is available for $15 per year from VIPER, PO Box 43, Audubon PA 19407. ■



Shown here is the display for Game 6—VIP figure shooting at a moving target. This game is one of 20 contained in the VIP instruction manual.

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In the August 1974 issue of the IEEE Computer Society's magazine, *Computer*, an article appeared that described "FRED," a low-cost microcomputer system with graphics suitable for home entertainment and simple educational applications. I remember thinking at the time, "Wow, what a great idea!" Remember, this was in 1974. Unfortunately, the system was not yet available commercially for anywhere near the low-cost price.

By the time the system did finally arrive in the form of the COSMAC VIP, I was heavily involved in computer graphics at work and was the proud owner of a KIM-1 at home, so the novelty wasn't there anymore. Still, I was intrigued with the possibility of using a low-cost, graphics-based system, together with a turtle graphics* language, for teaching mathematics, programming concepts and logical thinking to my three elementary-school-age children.

The simple, clean, easy-to-use characteristics of the KIM-1 had already impressed me, and the VIP with its built-in cassette interface, hex keypad, ROM monitor and 2K RAM seemed to offer about the same capability with the added bonus of a built-in video graphics display. I went to my local distributor, bought a VIP kit (from stock) and was off and running.

Assembling the VIP

The VIP is available in both kit and assembled form. Since the kit is less expensive, I opted for it even though the idea of assembling another kit bothered me. The manufacturer's literature was also vague as to what I could really expect for my money in the way of standard versus optional features, expandability, software, etc. A couple of phone calls to the distributor revealed that he didn't know much either.

I was pleasantly surprised, however, when I finally had my hands on the hardware. The VIP board was very well built, complete with solder mask and printed parts layout. The parts themselves were clearly labeled and easy to find. The resistors were even arranged in numerical order by value, a very welcome improvement over the usual "grab-bag" type of packaging found in many kits.

The assembly instructions were complete and easy to follow. Leisurely assembly took about three hours. A few negative points, however, should be mentioned.

Most notable are the missing items necessary before you can do anything with the VIP. Although you could hardly expect to have a video monitor included at the VIP's low price, RCA should have at least discussed this very important "extra" and the various options available in a little more detail. A simple rf modulator circuit diagram or even a list of vendors would be very useful to beginners. The circuit shown in Fig. 1 works fine with my "elcheapo" TV.

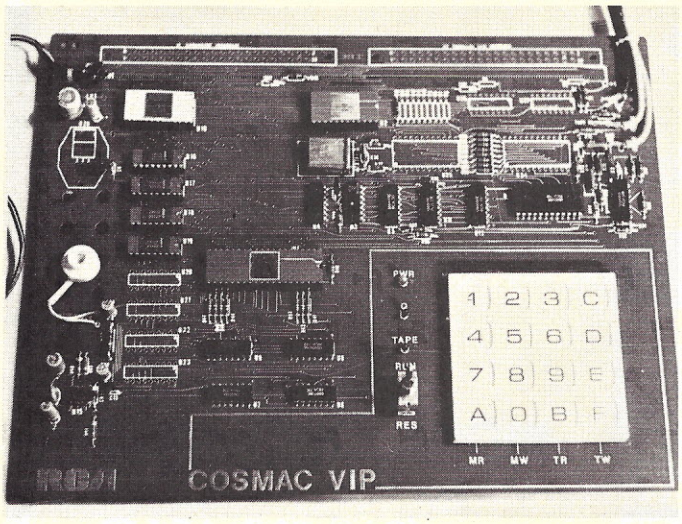
Other necessary items that the user must supply are the cassette cable, cassette recorder, video cable and speaker or earphone. This latter item requires some explanation, since a speaker is not usually included as a "necessary" item in a computer system! The VIP uses a touch-sensitive keypad that has no sensory feedback to the user to indicate that a key has been pressed.

Rather than making you guess, RCA has thoughtfully provided feedback in the form of a 555-type audio oscillator. The 555 is driven from the 1802's Q line, a 1-bit output port that is controlled by the ROM monitor to provide various audible prompts such as keyclicks.

Directions to "orient sockets properly" led to some confusion since three sockets were not polarized. Socket orientation is immaterial anyway. IC orientation is most important and, fortunately, easy to check due to excellent board marking.

After I assembled the VIP I tested it with two different video monitors: an expensive CONRAC studio monitor and an inexpensive monitor acquired on the surplus market. Neither one worked. When I examined the video output of the VIP with an oscilloscope, I found that the sync level was questionably low. The solution was to replace the 10k Ohm R1 with a 4.7k Ohm resistor. This was the only problem I experienced in bringing up the VIP . . . most remarkable in light of my previous unpleasant experience with various microcomputer kits.

Two manuals provide documentation for the VIP. One, an excellent, easy-to-read introduction to the VIP system, includes assembly instructions, operating instructions, software programming hints and instructions and 20 example pro-



The basic COSMAC VIP. The earphone at middle left and the cables at upper right must be added by the user; all else including the power supply is supplied. Note the pads for an extra 2K of RAM and an I/O port.

*The turtle graphics concept originated at MIT with the LOGO project. They used a pen plotter shaped like a turtle and controlled by a simple graphics language to teach programming concepts to eight-year-olds. Since then, the turtle concept has been carried over to a more abstract version consisting of just a spot on a CRT. The "turtle graphics" language constructs such as MOVE TURN and so on have been retained, however. The University of California at San Diego PASCAL project is one of the most recent systems to incorporate turtle graphics. They use it as their basic graphics language.

grams. The other manual contains a wealth of information on the 1802 CPU chip, which is not specific to the VIP. Included in this manual is an excellent tutorial on machine-language programming of the 1802.

Hardware

The VIP uses RCA's 1802 microprocessor chip as its CPU. The 1802 has an interesting instruction set resulting from its even more interesting architecture. The 1802 consists primarily of a set of sixteen 16-bit general-purpose registers, an 8-bit D register and an 8-bit arithmetic and logic unit (ALU).

Note the absence of such usual niceties as a program counter, stack pointer and index register. The 1802 takes care of these by providing three 4-bit registers that can be set under program control. One of these, the P register, is used to point to one of the 16 general registers, which is then used as the program counter.

Although the 1802 has no subroutine call instruction, one can be simulated easily by loading the subroutine address into a general register, then changing the P register to point to the new location counter. The return address will be left in the old register. A return instruction amounts to simply changing the P register back to its old contents. It's all a bit clumsy if you're used to the JSR and RTS instructions of the 6502, but interesting nevertheless.

Similarly, the 1802 provides the programmer with a 4-bit X register, which is used to point to another general register that can be used as an index register in memory reference instructions. The main shortcoming of this scheme is that the 16-bit registers must be loaded one byte at a time, and there is no capability for performing 16-bit arithmetic other than simply incrementing or decrementing the contents of a register.

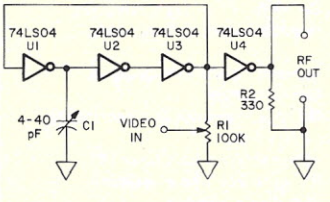
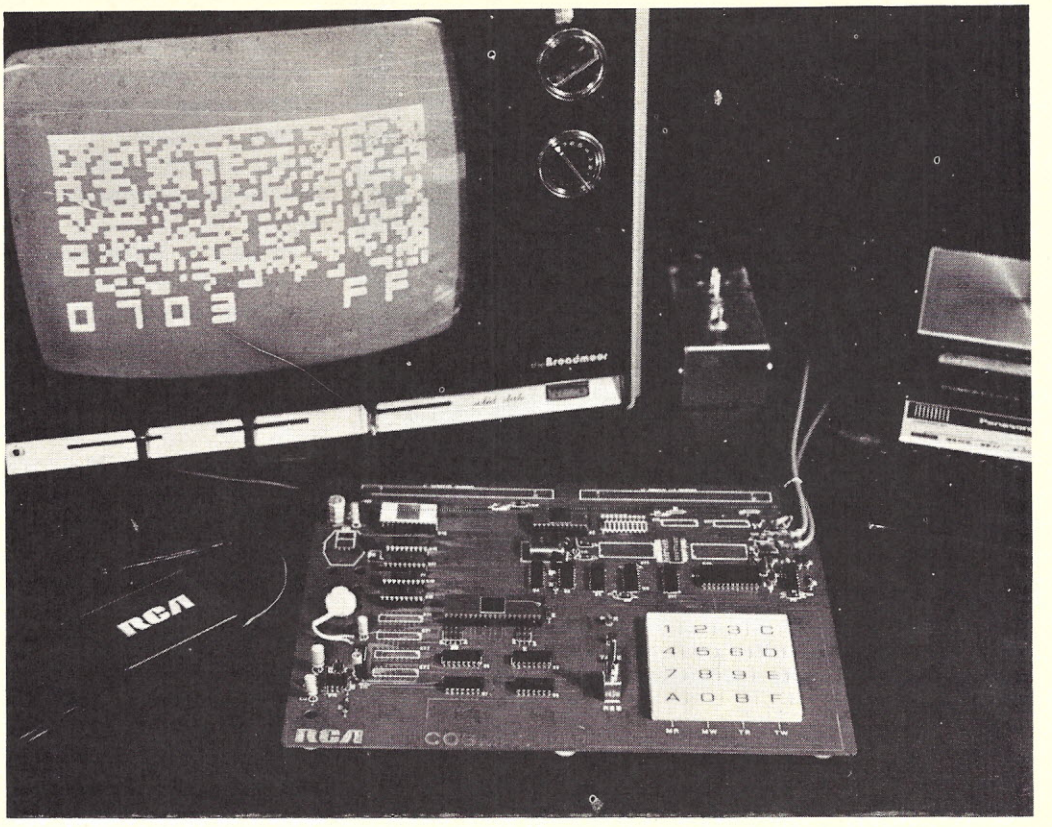


Fig. 1. Simple TTL oscillator circuit. U1 can be powered from a small 3 V battery. Mount all parts in a metal box to reduce interference to other TVs. Run coax to the VIP video output and twin lead to the TV's antenna lead.



A "complete" VIP system. Note the metal box containing the oscillator shown in Fig. 1.

The most unique feature of the 1802, however, is the ease with which DMA operations can be performed. Two lines are provided on the CPU chip for DMA in or out operations. When one of these lines is brought low, general register 0 is used as the address register in a memory read or write operation and is then incremented by one.

The VIP uses this feature and an 1861 video controller chip to provide a low-cost bit-map-type of graphics display. The 1861 provides all of the timing required for generation of horizontal and vertical sync pulses and performs parallel-to-serial conversion for video generation. In addition, the 1861 generates an interrupt at the beginning of each frame and generates eight DMA requests during each line for a total of 128 lines.

Thus the programmer only needs to provide an interrupt service routine that resets register 0 to point to the display area. The end result is a nice, clean 128 by 64 bit graphics display. By resetting register 0 more often during the display frame, you can display each line more than once, resulting in a smaller display memory at the expense of less resolution. The VIP's monitor makes use of a 64 by 32 bit resolution display.

Expansion

In addition to the CPU and video controller chips, the VIP includes 2K bytes of static RAM, a software-controlled audio cassette interface and a software-decoded hexadecimal keypad. The VIP's circuit board has foil for an additional 2K of RAM, 8-bit input port and an 8-bit output port.

The Q output line and the four external flag input lines provided by the 1802 could be used for I/O, but Q is already used for the tone generator and the cassette output interface; Flag 1 is used to control the video chip, and Flag 2 is used as the audio cassette input line. The 600 mA 5 volt power supply furnished with the VIP is not adequate to power the fully expanded (4K plus I/O ports) VIP (a fact I didn't discover until after I had purchased all of the expansion parts!).

Although all of the 1802's bus lines are brought out on an external connector, expansion to more than 4K is complicated by the CMOS technology used by the 1802, and by the 1802's multiplexing its memory address over an 8-bit bus. In other words, instead of using a simple 16-bit address bus like most other CPU chips, the 1802 sends out the high-order address byte followed by the low-order byte over the same eight lines. This makes it difficult to use existing expansion memory. Obviously, if your dream is a 64K byte "monster system" with floppy disks, printer and CRT, then the VIP is not for you!

Software

Although the bare-bones 1802 may not be the easiest machine to program, the VIP system ranks as one of the easiest of



Using the VIP is "kid stuff." The COSMAC VIP is one of the simplest micros to use. The lack of a complicated front panel is one reason why. Here the author's daughter is re-starting one of the game programs. Twenty educational game demonstration programs are provided.

the current small systems to use and program. This is partly due to the no-frills 512 byte ROM monitor.

Only four functions are provided: memory write (MW), memory read (MR), tape write (TW) and tape read (TR). A single RUN-RESET switch is provided. When this switch is thrown to RESET momentarily, then back to RUN with the "C" key depressed, the monitor is entered.

The next four keys are assumed to be a hex address. When these four digits are entered, the corresponding address and its contents are displayed in hex on the CRT screen. The user then has the option of selecting one of the four functions by pressing one of the keys: 0 (MW), A (MR), F (TW) or B (TR).

As each successive byte is entered in the MW mode, the monitor steps through sequential addresses, displaying each byte and its corresponding address on the monitor. This mode is very useful for entering a long string of data such as a program or a static display.

Since the monitor uses the top page of memory (0700 to 07FF) for display refresh, you merely need to enter the MW mode at 0700 and begin depositing data to draw a simple picture! This is a fun way for kids to practice binary-to-hex conversion. Have them draw a picture on a piece of paper ruled off into an array of 64 by 32 cells, then have them approximate their drawing as best they can by filling out the squares.

Convert the dark squares to 1s and the others to 0s; then convert the whole thing to hex, taking four binary digits at a time, and enter the resulting string starting at 0700. Voilà! The picture "magically" appears on the screen! Isn't it easy to illustrate such highly abstract and technical phenomena as digitization and quantization noise when you have the right tools?

CHIP-8

The other reason the VIP is so easy to use and program is the CHIP-8 language provided by RCA. CHIP-8 is an interpreter that executes programs written in a language whose features lie somewhere between machine language and Tiny BASIC. You must still hand-assemble and enter the programs in hex, but the language features are more on a par with those in Tiny BASIC.

Unlike Tiny BASIC, there are only 16 one-byte variables allowed, and only the operations +, −, AND and OR are allowed. There are also a random number generation function, GOTO, conditional skip instructions, GOSUB, binary-to-decimal conversion, erase display function, display pattern function and a machine-language routine CALL feature.

Program A, which moves a dot randomly around the screen, illustrates many of the features of CHIP-8. The first column is the location (in hex), the second is the instruction in machine code, the third is a sort of pseudo-code used to "comment" the sample programs in the VIP manual (there are 20 of them) and the fourth column is a more descriptive narrative.

The 31 different CHIP-8 functions form an interesting "tiny" language for writing simple interactive graphics programs. CHIP-8 deserves more attention than it has received. It is a concept that could very easily be applied to other display systems as well.

Educational Potential

At this point, some of you may be saying, "Well, the VIP looks like a pretty cute microcomputer with a neat little display for playing games and the like, but what has that got to do with educational applications?" The answer to that question is, "not much" if you equate educational applications with teaching BASIC or FORTRAN or running CAI applications such as PLATO.

On the other hand, RCA has included a "game" program (which previously appeared in *Creative Computing*) called "Strike Nine," which, I think, can do a lot more for providing both motivation and practice in simple addition than a whole batch of the usual first- and second-grade problem assignments. Not only do the kids get a lot of good, simple addition practice while playing this "game," they get instant feedback about whether they are right or wrong, which is essential to the learning process.

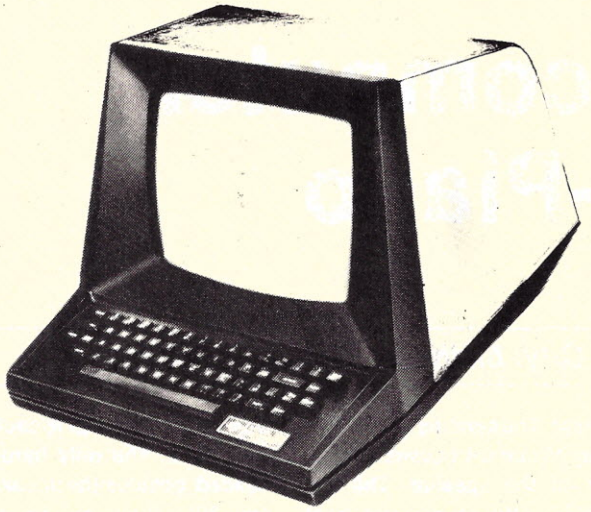
True, you can't even run a simple language such as BASIC on the bare-bones VIP, but I think we can do a much better job of providing a sense of computer awareness or "computer literacy" to the average person through the use of simple non-mathematical, graphics-oriented languages such as CHIP-8, rather than traditional, mathematics-based languages such as BASIC and FORTRAN.

All in all, the VIP rates as an excellent introduction to the world of microcomputers. As a kit, it was a pleasure to construct. It is extremely simple to operate—a real plus for the beginner. Most exciting of all is that we have just barely begun to tap the educational potential of this scale of truly low-cost, easy-to-use computer hardware.■

```
0200 00E0      ERASE              Erases the Screen
0202 6100      V1 = 0             Set initial X coordinate to 0
0204 6200      V2 = 0             Set initial Y coordinate to 0
0206 A22A      I = 22A            Set memory pointer to "dot" location
0208 8310   A  V3 = V1            Remember old X, Y coordinate . . .
020A 8420      V4 = V2              in variables V3 and V4.
020C D121      Display M1 @V1,V2  Display dot at location X, Y
020E 221A      GOSUB B            Set V5 to +1, −1 or 0 randomly
0210 8154      V1 = V1 + V5       Random motion in X direction
0212 221A      GOSUB B
0214 8254      V2 = V2 + V5       Random motion in Y direction
0216 D341      Display M1 @V3,V4  Erases old dot
0218 1208      GOTO A             Go back to point A and loop forever
The following subroutine returns V5 set to +1, −1 or 0
021A C601   B  V6 = RND(1)        V6 set to 0 or 1 for sign of V5
021C C501      V5 = RND(1)        V5 set to 0 or 1 for magnitude
021E 3601      Skip if V6 = 1     Skip if sign negative
0220 00EE      RETURN             Return to caller
0222 3501      Skip if V5 = 1     Skip if magnitude of result = 1
0224 00EE      RETURN
0226 65FF      V5 = FF            Return a −1
0228 00EE      RETURN
022A 8000                         Dot pattern for display
```

Program A.

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CHARACTERS PER LINE	80
NUMBER OF LINES	25
SCREEN	P4 phosphor (white)
TUBE SIZE(DIAGONAL)	12 inches (30.4 cm)
VIEWING AREA	54 square inches (137.1 cm)
CHARACTER SIZE	0.20" high x .08" wide (5.08 mm high x 2.03 mm wide)
REFRESH RATE	60 Hz (50 Hz available)
SCAN METHOD	Raster
CHARACTER GENERATION	5 x 7 character in an 8 x 10 dot matrix
CURSOR	Blinking block

MEMORY

TYPE	Random Access Memory
CAPACITY	2000 characters

OPERATOR CONTROLS

POWER ON/OFF SWITCH	On rear of unit
BRIGHTNESS CONTROL	On rear of unit

POWER REQUIREMENTS

Model 501 — 115 volts, 60 Hz, 100 watts nominal
Model 502 — 230 volts, 50 Hz, 100 watts nominal

INTERFACE

DATA FORMAT	
DATA BITS	7 serial, asynchronous
DATA BIT 8	1, 0 or deleted
PARITY	Odd, even or deleted with error displayed as DLE
STOP BITS	1 or 2
DATA TRANSFER RATE	50, 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 7200, 9600 BAUD

STANDARD FEATURES

INVERSE VIDEO	Operator or software selectable
TRANSMIT MODES	Half or full duplex (switch selectable)
DATA ENTRY	Top or bottom line
END OF LINE BELL	Switch selectable
CURSOR POSITIONING	X–Y
CURSOR ADDRESS	Load and read
DISPLAYABLE CHARACTERS	126 (including space)
CURSOR CONTROLS	Up, down, left, right, home, return
AUTOMATIC ROLL–UP	Switch selectable
AUTO CARRIAGE RETURN AND LINE FEED	Switch selectable
MONITOR MODE	Special "Monitor" Mode allows display of control codes (first two columns) of ASCII Code Chart).

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Reader Service—see page 179

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From Microcomputer to Micro-Piano

New Orleans: birthplace of jazz. Bossier City: birthplace of "Micro-Piano."

After graduating from high school in 1976, I came to Northeast Louisiana University not knowing the difference between a card reader and line printer. Also, not knowing what I wanted to major in, I scheduled classes in computer science and music (in which I had been active throughout high school). My first advisor in the computer science department said that my taking the music courses would be OK for one semester, but we would discuss my schedule selection after that. After two years I'm a confirmed computer science major, even though I still take a few music courses.

I've seen articles in books and magazines about programs in which the computer "plays" a song from instructions stored in memory. Some of them can play another melody by reading in another set of instructions. I wanted to have a program that would use the keyboard as piano keys and be able to reproduce any melody the user could play on a regular piano.

If I could write this program and get it working correctly, I could show the computer science department that the music classes I'd taken were not a waste of time. I think I have succeeded. In fact, another department here at NLU has its microcomputer programmed so that it can play "Dixie." Upon completion of my program, we told them to send people to us when they got tired of hearing "Dixie" because we could play requests!

The Program

The heart of the program is simply using a preselected value as a delay in sending eight volts of direct current to a small speaker and the same amount of delay of no direct current. The sending and taking away of current causes a vibration of the speaker. The frequency of the square wave sent to the speaker is altered by varying the time delays, which in turn varies the pitch.

A fellow computer science student, Tracy Ingersoll (also a musician), and I used her clarinet to find and tune these delays for the desired pitches. This turned out to be the most difficult part of the program since we had no idea where to look for the correct values; also, I confess my ear is not the best. Eventually we came up with a set of values that came as close as possible to the notes on a piano. For those with a knowledge of music, the computer programmed in the key of C.

The program was written for an Imsai 8080 system that includes a Cherry keyboard hooked up to PIO1 (parallel input/output port 1) of Imsai's MIO (multiple input/output) board. Input in this program is not strobe dependent; in fact, in order to prolong notes, the input strobe from the Cherry keyboard is never checked.

Our system also has a PIC-8 board to which a small, flat speaker is attached. Interrupts are not used to drive the program; the speaker is merely connected to the PIC-8 board, and current for the speaker can be controlled through it. A replacement for this would be a small speaker attached somewhere in the system in such a way that current to it could be controlled. The only hardware needed, besides the speaker, is any 8080 machine, an ASCII keyboard and less than 150 bytes of RAM.

Modifications

There are several changes that might be needed for the program to fit another system. As previously stated, input is written to be through PIO port 1. Depending on the system, this might need to be changed.

Our system is wired so that if no key of the keyboard is pressed, $7F_X$ (x for hexadecimal) is the bit pattern on the data lines; therefore, $7F_X$ is ignored when characters are input. The $7F_X$ may have to be changed on other systems. When the Z key is pressed, control will be transferred to the normal operating system; in our case this is 8004_X. The address of the operating system should be substituted for this address.

Controlling current to and from the speaker is done via the PIC-8 board. Current is sent to the speaker by sending a bit string that includes bit 7 set to the PIC-8 board. On our system this is accomplished through the instructions:

```
MVI A,80H
OUT OFDH
```

If a bit pattern with bit 7 equal to zero is sent out the same way, no current will go to the speaker. These instructions should be modified for other systems.
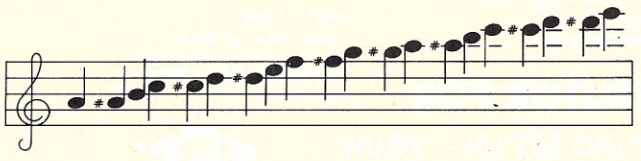


Fig. 1. Notes that can be played on the "piano."

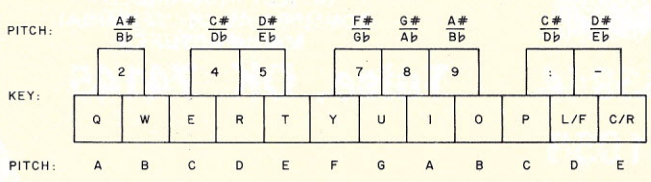


Fig. 2. How the various notes are represented on the keyboard.

The Keyboard

The keyboard is set up to hold one and one-fifth of an octave as shown in Fig. 1. The lowest note, A, corresponds to the letter Q on the keyboard, and the top note, E, is the carriage return. The sharps and/or flats are represented in the number row of the keyboard as shown in Fig. 2. As long as any of the illustrated keys are depressed, the corresponding pitch will be heard. If a Z is hit, control will transfer to the regular operating system. Any other keys pressed will be ignored.

Is your keyboard different from the one illustrated? If so, a simple change is all that is needed to correct the problem. Say, for example, your keyboard has a question mark (?) where the colon (:) is shown. Just replace $3A_X$ (ASCII for a colon) in the ASCII search table with $3F_X$ (ASCII for a question mark), and the problem will be solved.

If individual pitches need tuning on other systems it is also a simple procedure to alleviate the problem. If a pitch is sharp (too high), the delay value should be made larger, and vice versa for a flat pitch. For example, if the pitch F is sharp, look up the ASCII representation for "Y," the key representing the pitch F, and find its position in the ASCII search table. Since its position is ninth, find the ninth position in the delay table and increase that delay. Remember that a small change will make a big difference.

A suggestion to aid in playing the "piano" is to cover the keys that make sound with small squares of paper. Putting white paper over the keys in the letter row and black paper over the designated keys in the number row will make the keyboard look more like a regular piano keyboard.

That is all there is to it. I'd like to express many thanks to Dr. William Hyams, because as the old saying goes, "He taught me everything I know." Go adapt the program to fit your machine, and as the song says, "Roll over, Beethoven!" ■

```
0000  2A 68 00      A1: LHLD VALADR   *Load HL pointer with address
0003  EB              XCHG                of ASCII table and DE pointer
0004  2A 66 00        LHLD CHADDR       with address of delay table.
0007  06 14           MVI B,NUMVAL  *Load reg. B with number of notes.
0009  DB 01       IPT: IN 1          *Input ASCII character from keyboard.
000B  FE 7F           CPI 7FH
                                    *Loop until  key is pressed.
000D  CA 09 00        JZ IPT
0010  FE 5A           CPI 5AH       *Jump to operating system if
0012  CA 04 80        JZ 8004H          "Z" is pressed.
0015  4F              MOV C,A       *Copy character for comparison later.
0016  BE          FIND: CMP M       *Character = value in ASCII table?
0017  CA 23 00        JZ SOUND          If yes go make sound,
001A  23              INX H             otherwise continue
001B  13              INX D             searching table.
001C  05              DCR B         *Past table?  If yes, character
001D  CA 00 00        JZ A1             was bad, go get new one.
0020  C3 16 00        JMP FIND          If not, keep searching.
0023  3E 80       SOUND: MVI A,80H
                                    *Send current to speaker.
0025  D3 FD           OUT 0FDH
0027  1A              LDAX D        *Load reg. A with delay value.
0028  3D           B1: DCR A         *Keep current to speaker for
0029  C2 28 00        JNZ B1            length of the delay.
002C  3E 00           MVI A,0
                                    *Take current away from speaker.
002E  D3 FD           OUT 0FDH
0030  1A              LDAX D        *Load reg. A with delay value.
0031  3D           B2: DCR A         *No current to speaker for
0032  C2 31 00        JNZ B2            length of the delay.
0035  DB 01           IN 1          *Input ASCII character from keyboard.
0037  B9              CMP C         *If character is the same as before,
0038  CA 23 00        JZ SOUND          continue making sound,
003B  C3 00 00        JMP A1            otherwise find new delay value.
003E  51 32 57 45  CHARC: .BYTE 51H, 32H, 57H, 45H, *
      34 52 35 54               34H, 52H, 35H, 54H, *
      59 37 55 38               59H, 37H, 55H, 38H, *    ASCII TABLE
      49 39 4F 50               49H, 39H, 4FH, 50H, *
      3A 0A 2D 0D               3AH, 0AH, 2DH, 0DH *
      (14)            NUMVAL = .-CHARC      *Figure number of notes.
0052  98 94 8A 80  VALUES: .BYTE 98H, 94H, 8AH, 80H, *
      7C 73 6E 32               7CH, 73H, 6EH, 32H, *
      30 2D 29 27               30H, 2DH, 29H, 27H, *    DELAY TABLE
      24 22 20 1E               24H, 22H, 20H, 1EH, *
      1C 1A 19 18               1CH, 1AH, 19H, 18H, *
0066  3E 00        CHADDR: .WORD CHARC      *Calculate address of ASCII table.
0068  52 00        VALADR: .WORD VALUES     *Calculate address of delay table.
```

Program listing. The source was assembled using TDL's relocating Z-80 assembler. However, addresses are shown as they should be entered for those manually entering the program.

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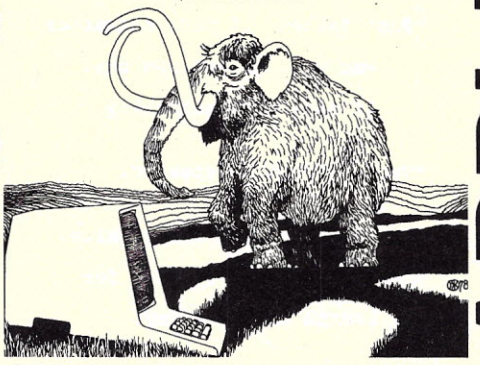
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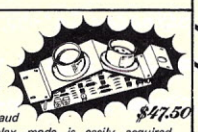
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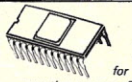
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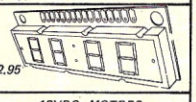
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wire

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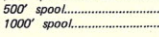
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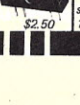
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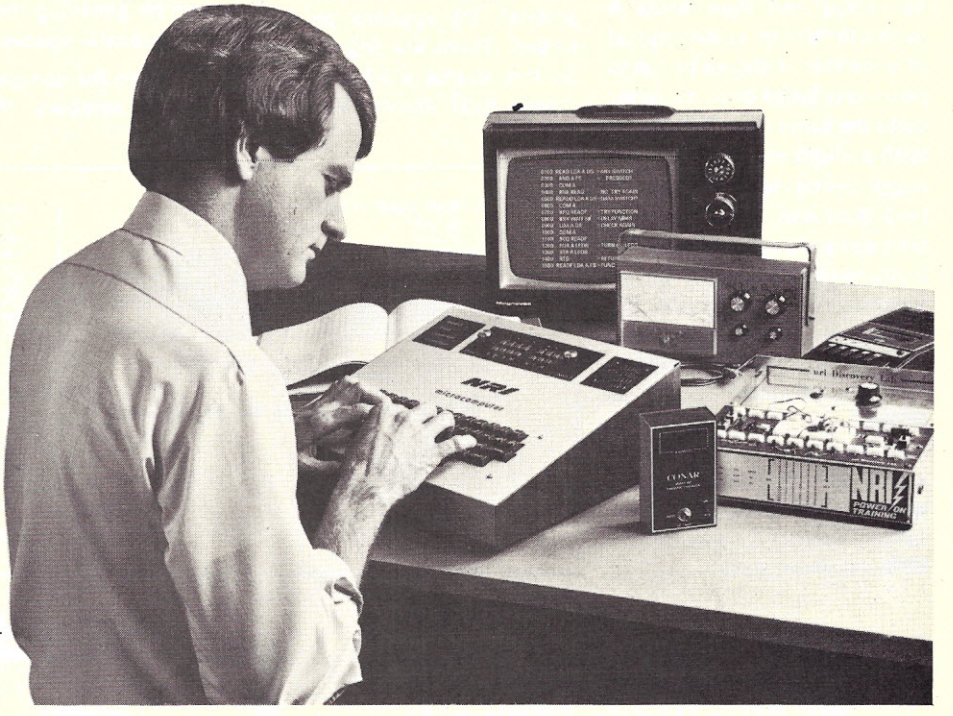
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Julie Martin
Verde Valley School
Sedona AZ 86336

A Game of Darts

No need to go down to the corner pub. Here's a dart game written in Tiny BASIC.

This program is a simulated game of dart throwing. I conceived and then wrote it (with a little help) at the request of a teacher. It should be fun to play many times over; it's never quite the same more than once. With a slight modification, the target can be made to move or a time limit can be put on. I'm sure someone can make further improvements. I would be interested in any changes or improvements anyone does make.

Also, I'm sure this program can be adapted to other BASICs, or other languages, with the slightest amount of work. This particular program was written for Tiny BASIC Extended Version 1.3 on a Sphere 6800 microcomputer.

How the Game Works

After the instructions, an asterisk (*) appears on the screen. There are 512 spaces on the 16-line x 32-character screen (0-31 across and 0-15 up). The player tries to hit the * with his dart (the letter y is used) by guessing the vertical and horizontal spaces.

To avoid the complexities of negative numbers, the origin isn't in the center, but in the bottom left-hand corner. After every shot the score is given and the screen is cleared. At the end of the game the total score is given.■

```
1   REM: GAME OF DARTS
2   CLEAR
3   N=0
10  PRINT"THIS IS THE GAME DARTS. TO PLAY"
20  PRINT"INPUT YOUR GUESS AS TO WHERE THE"
30  PRINT"'*'IS ON THE SCREEN BY GUESSING"
40  PRINT"SPACES OVER THEN UP;GOING ACROSS"
50  PRINT"SPACES ARE 0-31,GOING UP 0-15"
60  PRINT"STARTING AT THE BOTTOM LEFT CORNER"
70  PRINT
80  PRINT"TO START THE GAME, ENTER 1"
90  INPUT S\IFS=1GOTO 100
95  N=0
100 PRINT"INPUT THE NUM. OF DARTS TO THROW"
110 INPUT N
120 FOR I=1toN
130 POKE 57824+T-32*U,32
140 POKE Q,32
150 Z=512*RND()
160 Y=INT(Z/32)
170 X=Z-32*Y
180 Q=57824+X-32*Y
190 POKE Q,35
200 INPUT T,U
210 POKE 57824+T-32*U,89
220 IF T=INT(X) N=N+1
230 IFU=XN=N+1
240 PRINT"SCORE";N,
250 FOR J=1 to 500
260 NEXT J
270 NEXT I
280 PRINT"YOUR TOTAL SCORE IS";N;"DO YOU"
290 PRINT"WANT TO PLAY AGAIN?(1=YES, 0=NO)"
300 INPUT R
310 IF R=1 GOTO 95
320 PRINT"GOODBYE. SEE YOU LATER."
330 END
```

Program listing.

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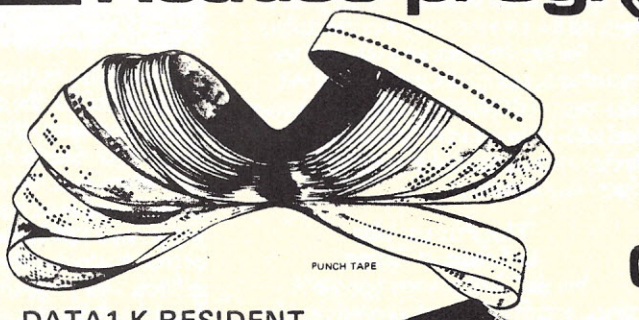
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✓ Reader Service—see page 179



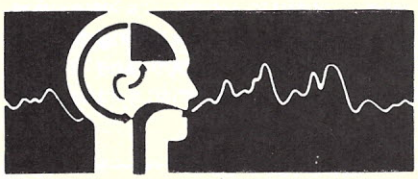
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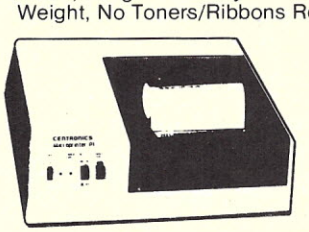
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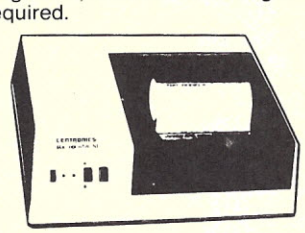
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Prettyprinting with Microsoft BASIC

You can use the colon to skip lines and indent with Microsoft BASIC.

Wallace Kendall
9002 Dunloggin Road
Ellicott City MD 21043

As a novice programmer but an experienced writer, I admired structured programming (which they tell me can't be done in BASIC) and its distant relative Prettyprinting, which they tell me should be possible.

Sure, I could indent when I wrote a program with my OSI Microsoft BASIC and I could skip a line wherever I wanted to. But then when I called on the computer to LIST the program I had written, all the lines came out flush left, and the blank lines had disappeared.

This annoyed me, not only because I wanted to show better on paper how the programs were organized, but also because I had invested $5.95 in John M. Nevison's *The Little Book of BASIC Style,* and if I couldn't skip lines or indent, it would appear that I had wasted nearly six bucks.

What I Did

Having studied BASIC for a few weeks and therefore become an expert, I wrote to Bill Gates, president of Microsoft, to suggest how he might correct this sad deficiency in what I thought was otherwise a very fine BASIC.

With becoming modesty, I refrained from telling Mr. Gates that I was now an expert. I wrote, "I don't know what problems might be involved, but I wonder whether it might be possible for you to offer a patch that would make it possible to skip lines and to indent. I, for one, would be willing to buy a patch that would do this and I suspect that many others would.

"This isn't a complaint about the BASIC! I like it very much and I'm looking forward to getting the 12K version. But if you could provide a patch, as I described, I'd like it even better."

Mr. Gates did not rise to the bait of a million-dollar market waiting out there. Instead, he wrote me:

"I don't have a patch for what you want to do, but by putting a ":" (colon) on the lines you want to be blank and by using ":" before any indentation, you can achieve the desired effect. I hope you find this useful, and thanks for your kind comments."

I tried it, and it works. Now you know, too, and if you have the Microsoft BASIC you, too, can print pretty programs.

The Program

This program shows how use of the colon makes it possible to skip lines and to indent with Microsoft BASIC. The colon does not affect the program (but uses a byte or two of memory, I suppose). If I had not used it, the LIST command would have started all the lines at the left margin; all the blank lines would have been eliminated. "Prettyprinting" helps the reader understand the program.

The program shows how the algorithm starts with values above and below pi and narrows the gap. Each figure printed represents the last of a series of 1000 of the loops that start with Line 80. With the OSI Challenger running on its 6502 chip, 1000 loops are completed in about 12.5 seconds.

The program is a "forever" loop; it keeps running until it is stopped. When Control C was pressed to stop it here, it was about to execute the instruction on Line 80 after having done so between 18,000 and 19,000 times in less than 4 minutes. ■

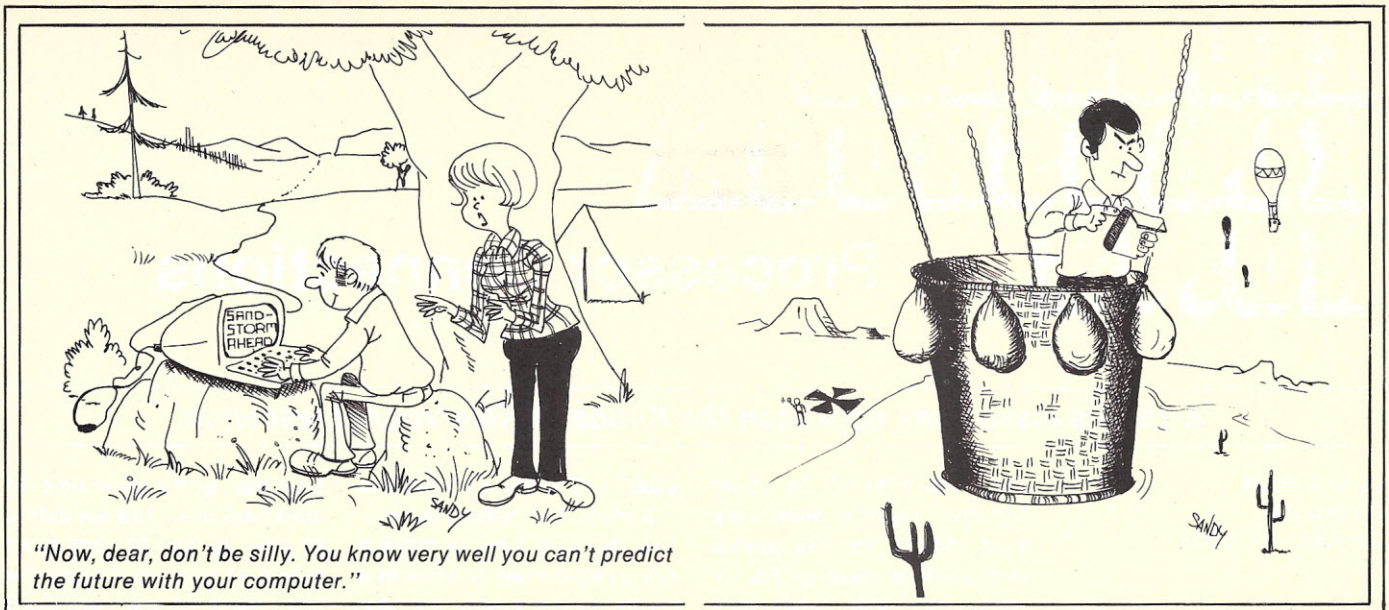
```
Pi = 4(1-1/3+1/5-1/7+1/9-1/11 . . . . . .)
LIST

 10 REM   COMPUTING PI BY AN ALTERNATING INFINITE SERIES
 20 REM   WALLACE KENDALL   5/15/78
 30 REM   FILED IN DATA DISK 3, TRACK 50
 40 :
 50 :
 60 N = 1: D = 1
 70 :
 80 FOR I = 1 TO 999
 90 :      P = P + N/D
100 :      D = D + 2
110 :      N = -N
120 :      NEXT I
140 :      PRINT P*4
150 GOTO 80
160 :
170 END
OK

RUN
 3.14259
 3.14109
 3.14193
 3.14135
 3.1418
 3.14144
 3.14175
 3.14148
 3.14171
 3.1415
 3.1417
 3.14152
 3.14168
 3.14154
 3.14167
 3.14154
 3.14167
 3.14155

BREAK IN  80
OK
```

Program listing.



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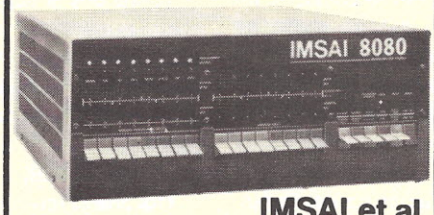
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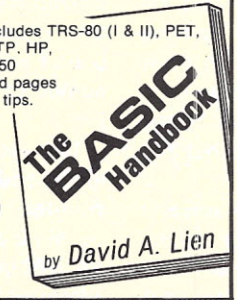
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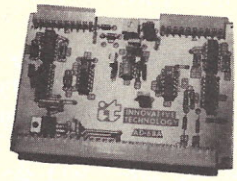
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KILOBAUD KLASSROOM NO. 13

Processor Connections

With this lesson, we approach the Kilobaud Klassroom krescendo.

Peter A. Stark
PO Box 209
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This time we look at the processor itself. No, we're not about to pry one open and look inside. Instead, we'll examine the connections we have to make to the microprocessor IC. Let's start with the most obvious.

Power-Supply Connections

You can tell a lot about a microprocessor by looking at the power-supply voltages it needs. For example, the first microprocessors were built with P-channel MOS (PMOS) circuitry; that is, they used P-channel MOSFET transistors in their logic circuits. Since a P-channel MOSFET transistor needs a negative supply voltage on its drain terminal, these ICs relied heavily on negative voltage power supplies. (The drain is analogous to the collector of a standard bipolar transistor or the plate of the tube.)

The only PMOS processor still around is TI's TMS-1000, which is still being used in controllers; it uses a single −15 volt power supply. National Semiconductor's older SC/MP chip, which was also PMOS, used +5 volts and −7 volts, with the −7 volt supply providing more power than the +5 volt supply, which was only used for the output circuitry and internal biasing.

The first N-channel MOS (NMOS) processors also used both positive and negative supplies, but now the positive supplies took more of the power and the negative ones were used mostly for low-current uses such as biasing. For instance, the 8080A needs three power sources: V_{DD} = +12 volts; V_{CC} = +5 volts; V_{BB} = −5 volts. Typical systems require a total of about 100 mA from the +12 and +5 volt supplies, but only 0.01 mA from the −5 volt supply. The newer processors, the 6800, 6502, Z-80, 8048, 2650, etc., all require a single +5 volt supply. In all cases, this voltage must be carefully regulated, typically within five percent of 5 volts.

The CMOS processors also require just a single power supply, but this voltage need not be kept at a precise value. For instance, RCA's COSMAC will work with voltages in the range of +3 to +12 volts; Intersil's 6100 will take from +4 to +11 volts. (The only reason for the higher voltages is that they permit faster operation. Hence, CMOS processors pushed to very fast speeds may need power supplies that are regulated and kept very close to the upper limit.)

From this description, you're probably saying to yourself, "Aha, I get it. The old processors required some weird supply voltages, whereas all the new, modern ones just need a single voltage." As it turns out, that's not so.

One of the newer processors around is TI's TMS-9900, a 16-bit processor used by Technico and a few others in fairly sophisticated—and expensive—systems. This new NMOS processor needs exactly the same voltages as the "old" 8080: +12 volts, +5 volts and −5 volts. The reason is probably that you have to make a few compromises to stick to a single power-supply voltage, and TI wanted to put so much into the TMS-9900 chip that they just couldn't keep the single supply voltage.

In most home or personal computers, the use of one or three power-supply voltages doesn't make much difference. Most systems provide +12 and −12 volt power supplies even if their processors don't need them because these are needed for the RS-232C output circuitry in the serial interface, and often other parts of the computer as well.

The one place where a single supply makes a difference is in very low-cost, large-volume applications such as appliances, automobile controllers and the like. Since the TMS-9900 is not going to be used there anyway, its use of three power supplies doesn't much matter.

Clock Signals

Every microprocessor relies for its timing on a clock signal from a clock oscillator. This is another area that to some extent distinguishes old microprocessors from new ones. All the early microprocessors required a clock signal from an external clock circuit. In most cases, this signal had to be a "nonoverlapping two-phase clock." Fig. 1a shows what this means.

The two-phase clock actually consists of two separate clock signals, called Ø1 and Ø2. They have the same frequency, but are timed so they are never both high at the same time. Ø1 goes back down to a low before Ø2 goes up, and Ø2 goes down before Ø1 goes up. Hence, the high parts of the two clock signals never overlap.

The clock signals in Fig. 1a are somewhat idealized; in practice they don't look nearly as neat. Fig. 1b shows the signal the way it might really appear in a typical 8080 system, complete with some overshoots (usually called ringing). As long as the ringing is not excessive, it has little effect on circuit operation.

In most 8080 systems, Ø2 is substantially longer than Ø1, and the beginning of Ø2 almost overlaps the end of Ø1. This is because of the way the two clock signals are generated. Although early 8080 systems used clock circuits made up out of several ICs and other components, more recent 8080 systems use the 8224 Clock Generator and Driver. This IC contains a crystal-controlled clock oscillator, which drives a mod-9 counter that counts from 0 through 8. This oscillator runs at a frequency nine times higher than the final clock frequency; thus if the 8080 runs at a clock frequency of 1 MHz, the crystal oscillator in the 8224 will run at 9 MHz. This oscillator then divides the 1 MHz clock period into nine parts, shown numbered from 0 through 8 in Fig. 2.

Two decoders then generate the Ø1 and Ø2 signals from this counter. Ø1 goes up during counts 0 and 1 of the counter, while Ø2 goes up during counts 2 through 6. This automatically means that Ø2 will be 2 ½ times

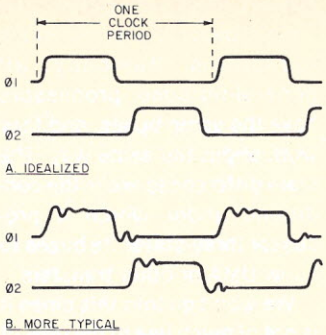


Fig. 1. Nonoverlapping two-phase clock.

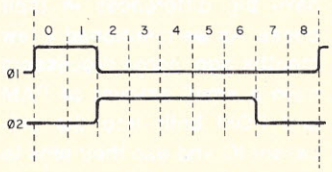


Fig. 2. Output of the 8224 clock generator and driver.

longer than Ø1. It also explains why the end of Ø1 and the beginning of Ø2 almost overlap, whereas there is a relatively long time interval between the end of Ø2 and the beginning of the next Ø1.

The other popular processor that uses a two-phase clock is Motorola's MC6800. In this processor, Ø1 and Ø2 are usually the same width, but in the case of the 6800, the two clock inputs are not TTL compatible. Either a discrete transistor driver circuit has to be built, or else you have to use one of Motorola's special clock drivers such as the MC6871 or MC6875. Both approaches are used; for example, the older Southwest Technical Products 6800 systems used a discrete transistor clock driver, while the newer SWTP models use the MC6875 clock driver. Heath's ET-3400 microprocessor trainer also uses the 6800-6875 combination.

At this point you probably suspect that any processor that can get by with just a single clock is much easier to use. This is certainly true. Keep in mind that both the 8080 and the 6800 are relatively old designs at this point; they have been followed by many newer processors. Almost every one of these requires just a single-phase clock.

In fact, many of the newer processors have the clock oscillators right on the processor chip. All that is needed is an external frequency-determining circuit that connects to the on-chip oscillator and maintains the frequency constant.

Fig. 3 shows the three different kinds of clock circuits microprocessors use. Fig. 3a shows a typical 8080 circuit, with an 8224 clock generator feeding the 8080 with the Ø1 and Ø2 clock signals. The oscillating frequency of the 8224 is controlled by a crystal (more information on that below, starting with the last paragraph in this column).

Fig. 3b shows the clock circuit of a Z-80 processor. Since only a single clock signal is required, instead of a carefully timed two-phase clock, almost any kind of a clock oscillator will do. Only a single clock line connects the two.

Fig. 3c is an example of a processor that has the clock oscillator right on the IC. This category includes the SC/MP, shown in the figure, and also others such as the 6502. In this case a crystal can be connected directly to the processor IC.

Although the crystal can often be connected directly to the processor pins, most of the time an extra RC network must be connected as shown here to prevent the crystal from oscillating on a multiple of its design frequency; that is the function of the two resistors and the capacitor in Figure 3c.

I've used the word crystal a few times, but what is a crystal? Hams and CB buffs already know the word—a crystal is the same component that keeps a transmitter or receiver tuned to a fixed frequency.

Fig. 4 shows the inside of a typical crystal. The heart of the device is a quartz disk roughly the size of a dime, but thinner. Quartz is a fragile crystalline material with a very high resistance—in fact, it behaves almost like an insulator. If you connect an ohmmeter to two points on a crystal, you will measure a very high resistance, almost an open circuit. Nevertheless, quartz has some interesting electrical properties.

If you connect two terminals to a thin piece of quartz and then put a voltage across the terminals, the quartz will change dimensions slightly. Depending on just where the terminals are, the chunk of quartz may bend, change thickness or change length. On the other hand, if you put a very sensitive voltmeter across the terminals and then apply a mechanical force to the crystal, you will measure a voltage. Years ago quartz was used to make phono cartridges, where a very small motion of the needle in a record groove produced a bending of the quartz, which then produced an electrical output.

In a frequency-determining crystal, the quartz crystal is shaped like a thin disk. A conducting plating in the shape of half a dumbbell is plated on each side of the disk, with the plating being a circle in the middle of the disk and extending out to the edge (see Fig. 4). It extends out to opposite edges on the two sides and touches the two wire clips that hold the disk above the base. These clips support the quartz disk and also connect the two plated sides to the two pins. The two plated areas on the two sides are the terminals. A voltage across them deforms the crystal, and a movement of the crystal produces a voltage.

Like any mechanical device, the crystal has a mechanical resonant frequency. Strike it, and it vibrates like a tuning fork. If you put a small voltage pulse across the terminals, it will vibrate and produce an output ac signal at its mechanical resonant frequency.

Thus the mechanical resonance is transformed into an electrical resonance. In a typical digital circuit, the crystal is put into a feedback path around an amplifier. Since the crystal can only vibrate at its resonant frequency, it will only absorb and release power to the circuit at that frequency. The entire circuit winds up oscillating at the crystal's resonant frequency.

Since this frequency depends on the mechanical characteristics of the crystal, it tends to stay constant. Hence, crystal oscillators oscillate at a constant frequency very close—within .005 percent or so—to the design frequency.

The only catch is that sometimes the crystal can oscillate at roughly a multiple of its fundamental frequency. This is called an overtone frequency and results because several parts of the crystal are oscillating at the same time, rather than the crystal oscillating as a whole. In this case, an RC network is often placed in series/parallel with the crystal, as in Fig. 3c, to get rid of these high-frequency oscillations and force the crystal to oscillate on its fundamental frequency.

Each of these circuits in Fig. 3 shows a crystal as part of

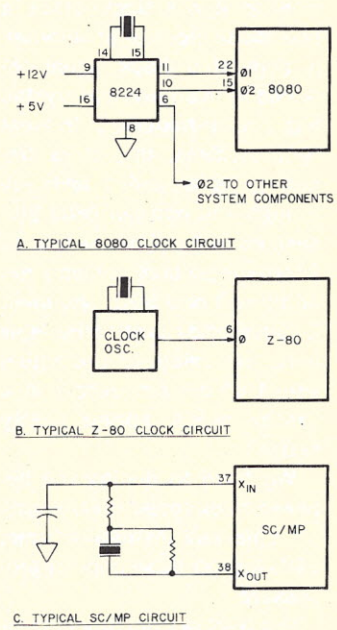


Fig. 3. Three kinds of clock circuits.

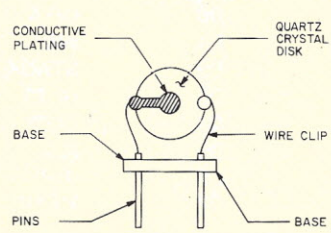


Fig. 4. The inside of a crystal.

the clock circuit. A crystal is used whenever the clock frequency of the processor has to be held at a specific value. If the clock frequency need not be that constant in a system, the crystal can be replaced with an LC, or more likely RC, circuit. It will still oscillate, but now the oscillation frequency will depend on the tolerance of the resistor and capacitor components and may be off by 10 percent or more. As the temperature changes or the components age, the frequency may also change by large amounts, whereas in a crystal oscillator circuit it would have stayed fairly constant.

Processor Operating Speed

What is the clock speed in microcomputer systems? You've often heard the comment that "my processor is running at 2 MHz" or something like that. What does it mean in terms of operating speed?

The clock signal coming to the processor, regardless of whether it is a single clock, a two-phase clock or an internally generated clock signal obtained from an external crystal, has a fixed frequency. In most 6800 systems, this clock frequency is around 1 MHz (although you can get 6800 processors that will run as fast as 2 MHz); most 8080 systems run at either 1 or 2 MHz, and most Z-80 systems run at 4 MHz. How does this relate to the actual speed of the processor? Is a faster clock speed really faster?

We have to distinguish between clock speed, machine cycle time and instruction time. Let's look at three popular processors.

In a 6800 system running at a clock frequency of 1 MHz, each cycle of the clock takes 1 microsecond. During this microsecond, there is one pulse of the Ø1 clock, followed by one pulse of the Ø2 clock. One memory operation, either a read or a write, also takes a microsecond. Hence, a 1-byte instruction can be fetched out of memory in one clock cycle, a 2-byte instruction in two cycles, a 3-byte instruction in three.

But after an instruction is fetched from memory, the processor needs time to perform it. This is done during succeeding clock cycles. The shortest instructions take one cycle to fetch the instruction from memory and another cycle to perform it. Some of the longer instructions take three cycles to get the instruction and six or more to perform it. Instruction execution times range from 2 to 12 cycles, which works out to 2 to 12 microseconds with a 1 MHz clock. But most instructions work out to 5 microseconds or less.

Let's compare that to an 8080 running with a 2 MHz clock. At that frequency, one clock cycle takes 0.5 microsecond. So far, the 8080 appears to operate faster than a 6800.

A so-called machine cycle on the 8080 takes three to five clock cycles, and a memory cycle takes the same time. Moreover, a complete instruction may require anywhere from one to five machine cycles. The clock cycles in a machine cycle are called T1, T2, T3, T4 and T5; the machine cycles in an instruction are called MC1 through MC5.

In the shortest 8080 instruction, clock cycles T1 through T3 of one machine cycle (MC1) are used to fetch a 1-byte instruction out of memory, and T4 is used to perform it. Thus this instruction takes four clock cycles to perform, for the same 2 microseconds as the fastest 6800 instruction. Longer instructions take as many as five machine cycles and 18 clock cycles, for a total of 9 microseconds. Most 8080 instructions execute in ten cycles or less, for a total of 5 microseconds or less; this works out to about the same instruction time as a 6800.

The clock timing of the Z-80 is similar to that of the 8080. A machine cycle consists of three to six clock periods, and instructions contain from one to six machine cycles. The shortest instruction takes four clock cycles, which works out to 1 microsecond at a 4 MHz clock rate. Most instructions require under 10-12 clock cycles, so most of them execute in 3 microseconds or even less—with a 4 MHz clock. However, some instructions require as many as 23 clock cycles, which is almost 6 microseconds.

As you can see, the Z-80 executes typical instructions in roughly half the time of an 8080 or 6800; moreover, some of its instructions are more powerful than those of either the 6800 or 8080, so the overall time saving can be greater. But to achieve this faster running time, it requires a higher frequency clock. To allow this, you need a faster memory.

Anyhow, comparing cycle times and clock rates is a confusing issue because it doesn't tell the whole story. The power of the instructions available and their suitability for a particular program greatly affects the overall running speed of the program. If one processor executes instructions twice as fast as another, but needs three times as many instructions to do a given job, then obviously it will perform slower. Judging how capable the instructions of a particular processor are is often a matter of personal judgment, and different people will come to different conclusions.

Address and Data Buses

We needn't say much about the buses on different processors. We've already studied them in past installments of the Klassroom. Basically, all general-purpose processors have the same buses, and they work about the same way. The main differences are in the conditions under which a processor three-states its buses to allow DMA or other transfers.

We won't go into this since it is not of much use to the user of a small business or personal computer, but those processors that are designed for controller use rather than processing may have big differences in their buses. As we mentioned a few months ago, some processors have a small amount of RAM and ROM built into the processor IC and use their pins to provide I/O ports rather than bus connections. This includes Intel's 8048 and 8748.

Other processors, either to allow some pins to be used for I/O or to reduce the number of pins, cut down the size of the address bus from 16 bits to 12 or 13 or multiplex part of the address bus onto the same pins as the data bus. This latter category of processors includes the Intel 8085, National Semiconductor's SC/MP and some of the processors in MOS Technology's 6500 series.

We won't concern ourselves with these stripped down processors since they are more useful for limited controller use than for full-fledged computing in general-purpose systems.

Read/Write Control

In addition to the bus, each processor needs some way of controlling the memory or I/O systems that connect to the buses. We've already looked at these in past installments of the Klassroom, so let's just review them very quickly.

One of the simplest read/write control schemes is that of the 6800 processor, shown in Fig. 5a. A VMA signal tells all memory and I/O when a valid address is on the bus, and an R/W signal tells them whether the cycle is to be a read or write cycle. The Ø2 signal is then used for timing. (Remember that memory and I/O share the same address

Data Bus Bit		Function
D0	INTA	Interrupt Acknowledge
D1	WO	Write Operation follows
D2	STACK	Stack operation follows
D3	HLTA	HaLT Acknowledge
D4	OUT	I/O device output follows
D5	M1	MC1 cycle (instruction fetch)
D6	INP	I/O device input follows
D7	MEMR	Read from MEMory follows

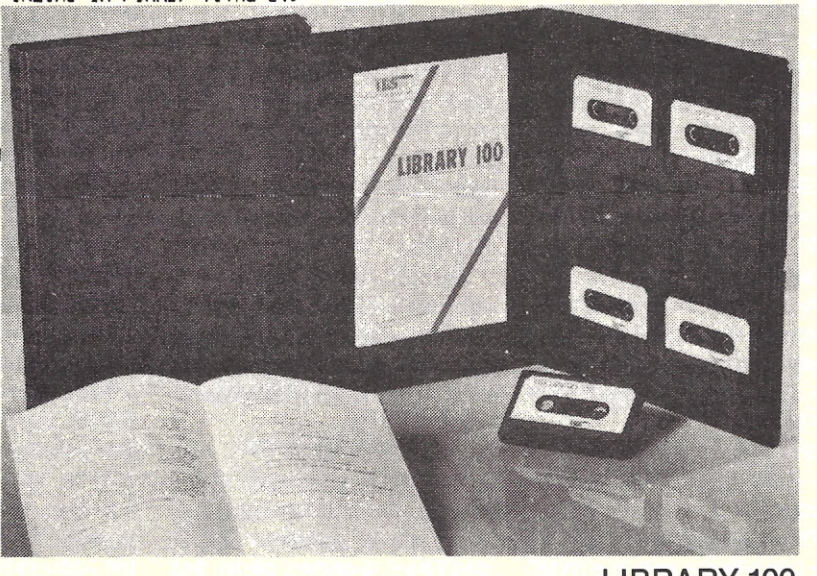
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space, so both use the same VMA and R/W signals.)

The 6502 is similar, except that it does not have the VMA signal. Addresses are always assumed to be valid.

Fig. 5b shows the read/write control lines of a Z-80. This time there are separate lines for Memory REQuest and I/O ReQuest, and for ReaD and WRite. No clock signal is used for timing, since the RD and WR signals are pulsed at the instant when data is read and written on the bus, and are used for data bus timing.

Fig. 5c shows the complex way in which the 8080 handles the same job. Information as to read or write cycles and selection of memory or I/O (called the status) is multiplexed onto the data bus during clock cycle T2 of an instruction fetch. External decoding and latching circuits must be used to grab this data off the bus at the right time.

In many systems, this job is handled by the 8228 System Controller. As shown in Fig. 5c, this is an IC that combines a full set of three-state buffers for the data bus with the latching circuits.

The 8080 transmits two data-bus control signals—WR, or WRite, which goes on when it is outputting data, and DBIN, which goes on during inputs. These signals are used by the 8228 to control which way it transmits data—to or from the 8080. At the beginning of clock cycle T2 of a fetch, the 8080 also outputs a SYNC signal, which is used by the 8228 to clock the status information off the data bus into a set of internal latches.

See Table 1 for how data bits are used for this status information.

The 8228 latches this data off the bus when it gets the SYNC signal, and decodes it. Among other things, bits D1, D4, D6 and D7 are used to provide the MEMR, MEMW, I/OR and I/OW signals shown in Figure 5c. These signals tell memory and I/O equipment that memory read, memory write, I/O read or I/O write cycles, respectively, are coming up.

Thus you can see that the 8080 needs some extra circuitry to decode these data-bus outputs to control memory and I/O. The 8228 makes the job easy, but at the expense of an additional chip. Many people don't look at this as a disadvantage, since they note that the 8228 provides buffering for the data bus at the same time. So it doesn't make much difference whether a plain buffer or an 8228 is used; in a sense, the status decoding is a free extra of the 8228, which merely replaces some other buffer.

This reasoning makes sense in systems that don't use the S-100 bus. But the S-100 bus was designed before the 8228 System Controller was developed, and happens to use two one-directional data buses, rather than one bidirectional bus. So the 8080's data bus has to be split into two 8-bit buses —one for input to the processor and one for output. The 8228 can't be used for buffering, since it only works with a single bidirectional data bus. Therefore, status decoding is an extra job in S-100 systems, separate from bus buffering.

Interrupt Lines

After spending five installments on I/O, along with a fairly lengthy discussion of interrupt systems, I'm not going to ask you to go through it again. Let's just say that all the processors have various interrupt pins.

The only thing to add is that data-bus bit D0 of the 8080 carries the interrupt acknowledge signal as part of the status. The 8228 latches it off the bus too.

Processor Reset

With every processor, there is the problem of how to start it. Most small systems today don't have a control panel, but rely on a small ROM to contain a monitor program of some kind, which is automatically started when the system is first turned on, or whenever a reset button is pressed. How is this done?

Every processor has a pin called RESET, or a similar name. Putting a signal on this

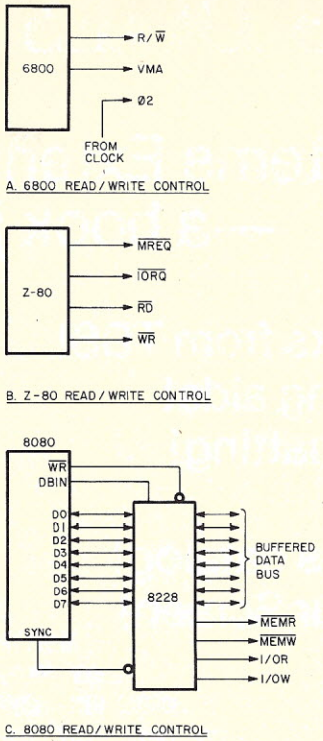


Fig. 5. Three kinds of read/write control.

line (either a low or high level, depending on the processor) will initialize the processor, clear various internal registers, turn off the interrupt system and start the ROM monitor program.

In general, the RESET signal must be supplied for at least a few clock cycles at the very beginning of operation, as power is being turned on. Otherwise, the processor will come up in some unknown state and will probably start trying to execute something, resulting in random action that might conceivably do something undesirable.

The details of what the RESET signal does depend on the processor. In an 8080 or Z-80 it resets the program counter (PC), an internal register that normally contains the address of the next instruction to be performed. Since the PC starts at 0000, the very first instruction performed after a reset is fetched out of memory location 0000. Hence, there usually has to be some ROM at address 0000 and above—unless you have a control panel with which you can load a program into RAM at address 0000 before starting the 8080.

Some systems using the 8080—the Heath H8, for instance—have anywhere from 256 bytes up to 12K, starting at address 0000, reserved for ROM and put all their RAM above that. Other systems have both ROM and RAM starting at address 0000 and use one of the control lines on the S-100 bus to switch in the ROM at system start-up, but switch in the RAM at other times. In this way they can support a full 64K of RAM, rather than have to devote a part of it permanently to ROM.

The 6800 and 6502 have the exact opposite situation. Instead of zeroing the program counter, these processors pull a jump address out of the two top locations in memory—addresses FFFE and FFFF—and then jump to the address stored there. This means that these processors need ROM at the very top of memory. Most 6800 systems have RAM memory starting at location 0000, and ROM extending from FFFF down.

Start/Stop and Bus Control Logic

This is an area of the greatest differences between processors—and also the greatest confusion. Most processors have four pins or so devoted to this function.

Let's describe these circuits in general terms first. The normal way of starting a microprocessor is to reset it. The normal way of stopping it is to have in the program a Halt instruction, or some other instruction that has the same effect. There are times, however, when we want to stop and restart it externally. This may happen for various reasons:

1. During a power-fail interrupt, after the data currently in memory is saved, we may want to hold the computer stopped so it won't do strange things while power is going off.

2. If a memory or I/O device needs extra time for an operation, we may want to slow down or temporarily stop the processor to gain some extra time.

3. During a direct memory access (DMA) operation we not

only want to stop the processor, but also disconnect it from all the buses by three-stating its outputs.

For the third reason, the start-stop logic is also interconnected with the bus control circuitry that three-states the buses and other control signals. If you're going to modify or design the start/stop or bus control logic, you will have to get the manufacturer's spec sheets for your processor and study them carefully. A book such as Adam Osborne's *An Introduction to Microcomputers* will also help put some of the explanations into easy language. Our discussion here will only touch the high points.

Let's look at the 6800 first. As Fig. 6a shows, there are four pins involved: HALT, TSC, DBE and BA.

The HALT signal does just that—when an external circuit grounds HALT, the 6800 finishes its current instruction and then halts. As soon as it is halted, it three-states the address and data buses and the R/W line. Then it tells the outside world that all the buses are free by turning on the BA, or Bus Available, line. This is an ideal time for DMA transfers. As soon as the HALT line is released, the 6800 waits for the next Ø1 clock pulse, and then turns off the BA, latches onto the buses again and continues as if nothing had happened.

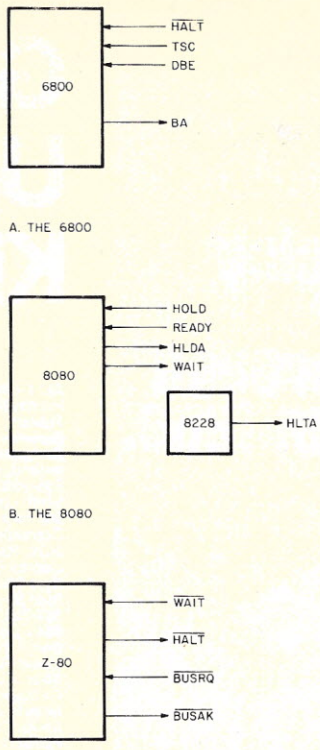


Fig. 6. Start/stop and bus-control signals.

The TSC and DBE signals are also used for three-stating the buses; but TSC three-states only the address bus, while DBE only three-states the data bus. Using both together, of course, three-states everything, and could also be used for disabling the processor for DMA transfers. (Keep in mind that this is just a very basic discussion—for instance, I didn't tell you that to use DBE or TSC you also have to turn off the clock; there are a lot of such details that have to be gleaned from the spec sheets if you are going to use these pins.)

Now here is an interesting point: it is possible to slow down the processor just by slowing down the clock. For instance, a machine cycle can be lengthened by lengthening the Ø2 clock pulse. This is a common way of slowing down the 6800 to give the memory or I/O a little extra time to work.

Fig. 6b shows the signals used by the 8080. The HOLD input is much like the 6800's HALT: it halts the processor at the end of the current instruction, three-states the buses to release them for DMA and lets the outside world know what is going on by turning on the HLDA, or HoLD Acknowledge output. (The HLDA is usually used by the 8228 controller and address-bus buffers to three-state their data-bus buffers.)

If memory or an I/O device needs more time to complete an operation, it can pull the READY input to ground. This tells the 8080 that external circuitry is not ready, and it enters a wait state during which it does nothing; to signal this state, it turns on the WAIT output.

There is a third way of stopping the 8080, and that is with a HLT instruction as part of a program. A HLTA (HaLT Acknowledge) signal is output on the data bus as part of the read/write status, and output by the 8228 (or whatever else is being used instead of the 8228). The only way to get out of a Halt state is either by resetting the processor or by generating an interrupt.

The timing of all of these signals is crucial, and external circuits that make use of these inputs and outputs have to strictly follow the timing that the 8080 needs.

Finally, Fig. 6c shows the Z-80 signals. WAIT is the same as the 8080's READY, but has a different name. In the 8080, the READY is high when external circuits are ready and is pulled low when they are not; in the Z-80 it is also normally high, and is pulled low when they want the Z-80 to wait . . . really the same thing. BUSRQ and BUSAK are bus-request and bus-acknowledge signals for three-stating the buses during DMA transfers.

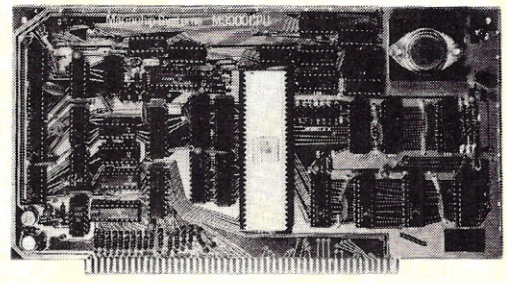
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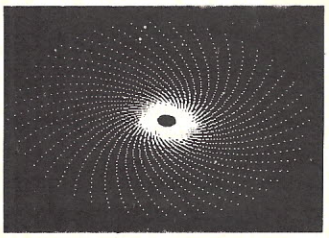
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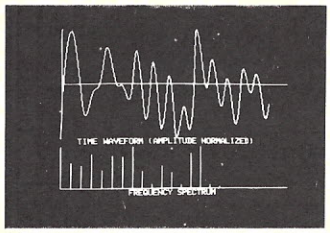
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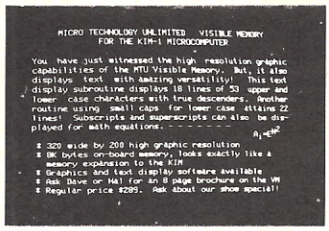
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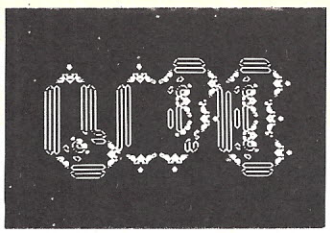
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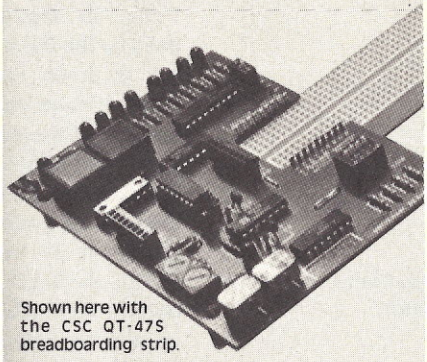
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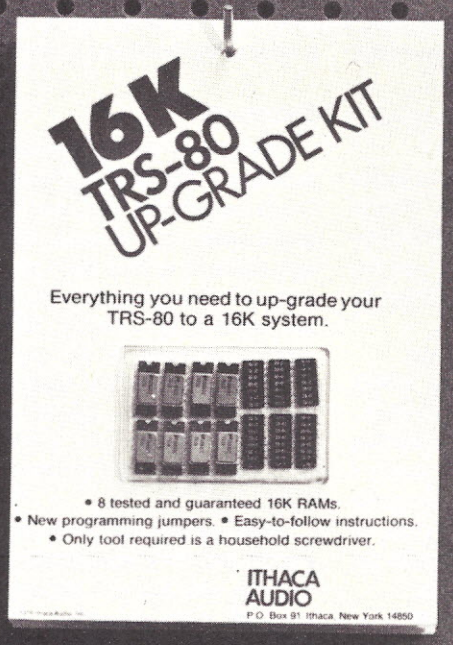
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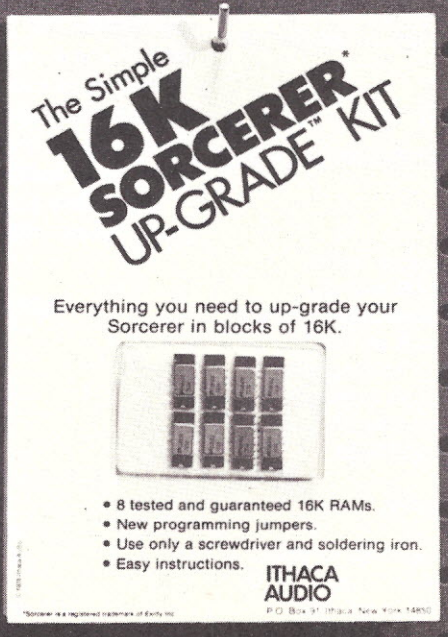


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MDOS

This Micropolis disk system review was written by the author of the data base management program described in the introductory article on data base management (page 54).

Helmar B. Herman
2218 Glen Canyon Rd.
Altadena CA 91001

I have been a user of Micropolis disks for almost two years. Both hardware and software have proven not only capable, but quite reliable.

When I was designing my system, I was faced with the problem of which disk drive to use. Desiring as much storage capability as possible, I was impressed with the specifications of the Micropolis drives but, at the same time, I was a bit apprehensive about data integrity at such a high density (315K per 5 1/4 inch diskette). I am pleased to be able to say that since my system became operational, I have not lost one bit (let alone byte) of data. And that's running on a Z-80 system at 4 MHz.

Until now, Micropolis has offered a BASIC-only operating system. It worked admirably, but I was eager for them to provide an assembler. Their BASIC system had the ability to call assembly-language subroutines, but there was no way to write and assemble any.

On March 1, 1978, Micropolis introduced their new operating system, which included not only an assembler, but also an entirely new, well-planned disk-operating system. This new operating system, called MDOS, is described below.

MDOS Format

The format of MDOS in storage is shown in Fig. 1. The storage up to X'2A00' is used by MDOS. The area beyond that is available for application programs. One of the more exciting features of MDOS is that many of the subroutines used by MDOS itself are available to user programs. More on this feature in the Assembler section.

Installation

The installation procedure for MDOS is about the same as it has been for the previous BASIC-only releases.

1. Place the master diskette in drive 0 and ready it.
2. Jump (via either front panel or monitor) to X'F400'. This is the location of the ROM bootstrap routine supplied with the system. The location may be moved elsewhere.
3. Wait for MDOS to load.
4. Modify the byte at X'4D0' (again via front panel or monitor) to the value corresponding to your system configuration (see Fig. 2). If your configuration is not one of those supported, there are instructions describing how to proceed.
5. Jump to location X'4D6'.

At this point, the system will sign on and you are up. To complete the SYSGEN, initialize and create a system diskette containing the newly tailored MDOS and a copy of all of the system files and programs on the master diskette. This system diskette is then used for normal day-to-day operations.

If you have a printer, you will have some additional steps, following step 5, to define the printer to the operating system.

Commands

There are 22 commands available in MDOS (see Fig. 3). These commands are used to manipulate data in main storage, perform various disk management functions and adjust the operating system. One handy command is the DISP command, which will display (dump) a file to the console (or printer) in hexadecimal format . . . a very useful tool in debugging.

When something other than the 22 resident commands is entered, the system assumes that the data entered is the name of a program (either system or user) to be loaded into the application program area and executed. Following the name of the program, up to four parameters may be entered, which will be passed to the executed program.

Assembler

The assembler is a two-pass, disk-to-disk assembler. The

X'0000' - X'0069'	Not used.
X'006A' - X'01BF'	Bootstrap and then system stack.
X'01A0' - X'146A'	Permanently resident I/O and disk control routines and associated buffers.
X'146B' - X'29FF'	Command executive and all user callable routines not in above area.
X'2A00' - X'nnnn'	The applications program area extends to the end of contiguous memory.
X'F400' - X'F5FF'	Bootstrap ROM as supplied by Micropolis.
X'F600' - X'F7FF'	Micropolis disk controller.

Fig. 1. MDOS storage layout. When BASIC is loaded, the BASIC interpreter extends from X'146B' to X'56FF'. From X'5700' to the end of contiguous memory is for BASIC programs.

NBR (hex)	Device
0	Altair 88-2S10
1	Imsai S102
2	Altair SIO A,B,C (not rev 0)
3	Altair SIO A,B,C (rev 0)
4	PTC 3P + S
5	Imsai MIO
6	Altair 88-4PIO
80	COMPAL-80
81	PTC SOL-20 WITH SOLOS 1.3

Fig. 2. MDOS system configuration options.

source input is a disk file (created and maintained by the line editor). The object output may be placed in memory and/or on disk.

One interesting capability of the assembler is the ability to accept input from and display data to the console during assembly. The value entered as input can then be used, for example, to determine a table size or, perhaps, the program's starting location. The assembler also has an IFT (if true) and IFF (if false) directive that allows portions of the program to not be assembled.

The capability of the MDOS assembler is illustrated through its ability to call 78 different subroutines resident in and used by MDOS itself (see Fig. 4). These subroutines take much of the drudgery out of coding in assembly language. Related routines have been designed to work well with each other so that the output from one can be directly used as input to another.

An example of a simple program using these subroutines is shown in Fig. 5. It accepts two hexadecimal numbers (0-FFF), multiplies them together and prints the answer. Note that when an application program is executed, MDOS provides a stack and a return address. Almost half of the executable statements in this sample program are calls to various MDOS subroutines.

The MDOS shared subroutines are logically divided into seven categories:

1. Console/printer I/O.
2. Text line parsing.
3. Logical disk file access.
4. Physical disk access.
5. Utility subroutines.
6. Extended integer arithmetic.
7. Special message output.

The availability and scope of these subroutines have several major impacts on assembly-language programming.

1. Program development time is shortened considerably. There is no longer any need to write and debug many of the more commonly used subroutines.

2. Program reliability is enhanced. Since these subroutines are used by MDOS itself, and MDOS does work, it can be assumed that the subroutines also work. If a bug should be found in an MDOS subroutine, after being corrected, all programs that use that subroutine will be automatically corrected also.

3. Programs will be smaller. The overhead of the MDOS operating system is no longer just overhead—it now contains many useful subroutines.

4. Assembly language under MDOS is raised almost to the level of a higher-level language.

COMP	Compare storage to storage
DUMP	Dump storage
ENTR	Enter data into storage
FILL	Fill storage with a value
MOVE	Move storage to storage
SEAR	Search storage for a value
SEARN	Search storage for the nonoccurrence of a value
CREATE	Create an empty file on disk
DISP	Display (dump) a file
FILES	Display the names of all of the files
FREE	Display the number of tracks still available
SCRATCH	Scratch (delete) a file
LOAD	Load a program
SAVE	Save a program (or data)
RENAME	Rename a disk file
TYPE	Change the attributes of a disk file
APP	Execute a program in the application program area
ASSIGN	Change the console/printer assignments
EXEC	Begin execution at a specified storage location
MATH	Perform hexadecimal arithmetic
PROMPT	Change the prompt message (default is ' ').
INIT	Initialize a disk

Fig. 3. MDOS commands.

Fig. 4. MDOS shared subroutines.

Console and Printer I/O

@CIN	CONSOLE INPUT
@COUT	CONSOLE OUTPUT
@CBRK	CONSOLE BREAK CHECK
@CDIN	CONSOLE DEVICE INPUT
@CDOUT	CONSOLE DEVICE OUTPUT
@CDBRK	CONSOLE DEVICE BREAK CHECK
@CDINIT	CONSOLE DEVICE INITIALIZATION
@LOUT	LIST OUTPUT
@LATN	LIST ATTENTION
@LDOUT	LIST DEVICE OUTPUT
@LDATN	LIST DEVICE ATTENTION
@LDINIT	LIST DEVICE INITIALIZATION
@CCRLF	CONSOLE LINE FEED CARRIAGE RETURN
@LCRLF	LIST LINE FEED CARRIAGE RETURN
@ASSIGN	ASSIGN
@CILINE	CONSOLE INPUT LINE
@HEXOUT	HEXADECIMAL OUTPUT
@HEXADDOUT	HEXADECIMAL ADDRESS OUTPUT
@HEXOUTSPC	HEXADECIMAL OUTPUT WITH SPACE
@SPACEOUT	SPACE OUT
@NLINEOUT	NEW LINE OUTPUT
@LINEOUT	LINE OUTPUT

Text Line Parsing

@PARAM	PARAMETER
@SKIPSPACE	SKIP SPACES
@SCAN	SCAN
@SEAR	SEARCH
@AHEXTBIN	ASCII HEX TO BINARY

File Access

@CREATE	CREATE A NEW FILE
@GFILESTAT	GET FILE STATUS
@DIRSEARCH	SEARCH THE DIRECTORY
@OPENFILE	OPEN A FILE
@CLOSEFILE	CLOSE A FILE
@RFILEINF	READ FILE INFORMATION
@SINXTRS	SET INDEX POSITION TO RECORD START
@RRECORDLEN	READ RECORD LENGTH
@RINXPOS	READ INDEX POSITION
@SINXPOS	SET INDEX POSITION
@INCINX	INCREMENT INDEX POSITION
@RFINXPOS	READ FROM INDEX POSITION
@RFINXPOSI	READ FROM INDEX POSITION/INC INDEX
@WTINXPOS	WRITE TO INDEX POSITION
@WTINXPOSI	WRITE TO INDEX POSITION/INC INDEX
@LOADDATA	LOAD DATA
@SAVEDATA	SAVE DATA
@DFINXPOSTEOF	DELETE FROM INDEX POS TO END OF REC
@DFINXPOS	DELETE FROM INDEX POS TO END OF FILE
@INCRECPOS	INCREMENT RECORD POSITION

File Management

@FREE	GET FREE TRACKS
@RENAME	RENAME A FILE
@TYPE	CHANGE FILE TYPE
@SCRATCH	SCRATCH A FILE

Physical Disk Access Routines

@GETASEC	GET A SECTOR
@PUTASEC	PUT A SECTOR
@WRITESECTOR	WRITE A SECTOR
@VERIFYSECTOR	VERIFY A SECTOR
@SEEKTRACK	SEEK TO A TRACK
@RESTOREDISK	RESTORE THE READ/WRITE HEAD

Processor Utilities

@HLADDA	ADD A TO HL
@INXM	INCREMENT MEMORY
@LHLINDEXED	LOAD HL INDIRECT INDEXED
@LHLI	LOAD HL INDIRECT
@TRANSDHC	TRANSFER FROM DE TO HL FOR C BYTES
@TRANSDHBC	TRANSFER FROM DE TO HL FOR BC BYTES
@TRANSDHBCR	TRANSFER FROM DE TO HL FOR BC REVERSE
@TRANSFILENAME	TRANSFER A FILENAME
@FILLZER	FILL WITH ZEROS
@FILLSPC	FILL WITH SPACES
@FILLA	FILL FROM THE A REGISTER
@COMPARE	COMPARE HL TO DE

Extended 8080 Integer Arithmetic (16 bits)

@DEADDHL	BC = DE + HL
@DESUBHL	BC = DE – HL
@DEMULHL	BC = DE*HL
@DEDIVHL	BC = DE/HL
@DEMODHL	BC = DE%HL (modulus)

Message Output

@DISKERROR	DISK ERROR MESSAGES
@CLOSEFILES	CLOSE ALL FILES
@ERRORMES	ERROR MESSAGES
@MESSAGEOUT	MESSAGE OUTPUT

5. Programs written on one Micropolis configuration will run on any other Micropolis configuration since the I/O functions (console, printer and disk) are in MDOS and have been tailored by each user during SYSGEN.

Other Utility Programs

LINEEDIT—The MDOS line editor program is a line-number-oriented editor with character-within-line-editing and global-search-and-change capabilities.

FILECOPY—A program that will copy and optionally rename disk files.

DISKCOPY—A program that will copy an entire diskette, track for track, to another diskette. There is a special procedure described for copying a diskette with only one drive.

SYMSAVE—A program that will create an assembler LINK file from the residual of a program just assembled. The new file will consist of a series of equate statements.

MDOS BASIC

The disk extended BASIC supplied with MDOS is essentially the same as the one supplied with the previous BASIC-only releases. The BASIC program has been modified to run under MDOS, and a new statement (LINK) has been added. The Micropolis BASIC has always had, and still does have, one disadvantage offset by several advantages.

Disadvantages

- Micropolis BASIC is somewhat slow. A "10 FOR X = 1 to 1000:NEXT X" loop takes about 2 1/2 seconds on a Z-80 at 4 MHz. Disk output from BASIC is slowed down because each record is verified (re-read) after it is written. I don't consider this a disadvantage, though, because this is a normal trade-off when performing disk I/O.

Advantages

- The disk file management capabilities are quite extensive.
- Numeric variables are variable in precision and may have up to 56 digits of precision.
- A full complement of string and numeric functions is available.
- There is the ability to assign console and/or printer output to the console and/or printer (or even disk) at execution time.
- There is a flow trace debugging aid.

```
        LINK    'SYSQ1'          ;LINK IN EQUATES
        LINK    'SYSQ2'          ;LINK IN EQUATES
        ORG     @APROGRAM        ;ORG TO BEGINNING
BEGIN   CALL    @CCRLF           ;START NEW LINE
        LXI     H,MSG1           ;POINT TO 1ST MESSAGE
        CALL    @CILINE          ;PRINT MSG AND GET 1ST NBR
        LXI     D,@INBUFF        ;POINT TO NUMBER ENTERED
        CALL    @AHEXTBIN        ;CONVERT TO BINARY
        SHLD    NUM1             ;SAVE THE 1ST NUMBER
        CALL    @CCRLF           ;START NEW LINE
        LXI     @H,MSG2          ;POINT TO 2ND MESSAGE
        CALL    @CILINE          ;PRINT MSG AND GET 2ND NBR
        LXI     H,MSG3           ;POINT TO ANSWER MESSAGE
        CALL    @NLINEOUT        ;PRINT ANSWER MESSAGE
        LXI     D,@INBUFF        ;POINT TO 2ND NUMBER ENTERED
        CALL    @AHEXTBIN        ;CONVERT TO BINARY
        XCHG                     ;MOVE 2ND NUMBER TO DE
        LHLD    NUM1             ;LOAD 1ST NUMBER
        CALL    @DEMULHL         ;MULTIPLY THE TWO NUMBERS
        MOV     H,B              ;MOVE ANSWER
        MOV     L,C              ;   TO HL
        CALL    @HEXADDOUT       ;PRINT THE ANSWER
        RET                      ;RETURN TO MDOS
MSG1    DTH     'ENTER THE FIRST HEX NUMBER (XXX)'
MSG2    DTH     'ENTER THE SECOND HEX NUMBER (XXX)'
MSG3    DTH     'THE ANSWER IS'
NUM1    DW      0
        END     BEGIN
```

Fig. 5. A sample program using shared subroutines.

Conclusion

In case it has not become apparent to the reader, I am very enthusiastic about Micropolis hardware and software.

The BASIC system is a joy to use. Little things, such as logical ANDing and ORing, upper/lowercase capability and the ability to assign output to terminal or printer devices at execution time, all add to the flexibility. As I write programs I occasionally wonder if the system will allow me to do *this* . . . and usually, it does.

The debugging package is much needed. Debugging programs without one can be very frustrating.

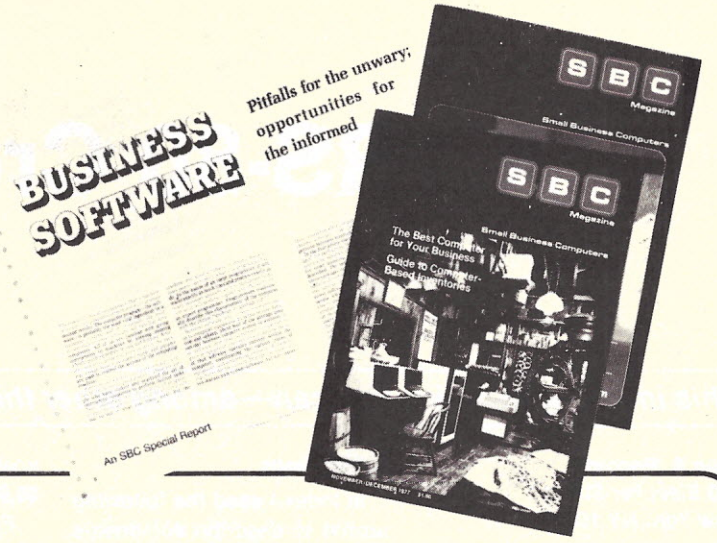
My profession is systems programmer working with large-scale IBM 370 systems. I *expect* the 370 hardware and software to work according to specifications . . . and it does (usually). It's a pleasure and a relief to see the same performance from a microcomputer system. ■

The latest release of MDOS, Release 4.0, is now available. According to Micropolis, some of the enhancements are:

1. A debugging package for assembly-language program development. Such things as breakpoints, single instruction cycling, memory and register dumping will be supported.
2. Five-percent-faster BASIC programs.
3. A BASIC EDIT function that will allow the editing of a single BASIC statement.
4. A BASIC renumber function.
5. A BASIC MERGE function that will allow two or more BASIC programs to be merged together.

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A TRS-80 Cross-Index

This index, with which you can—among other things—keep records, isn't just for lawyers.

John A. Records
100 Bleecker Street
New York NY 10012

My interest in computers is well known at the law firm where I work, and some of my colleagues recently asked about my views on law-firm applications for microcomputers. Since I had just ordered a Radio Shack TRS-80 with Level I BASIC and 4K of RAM and was working on a lawsuit involving hundreds of documents, I decided to see if the minimally configured TRS-80 could reduce the time I spent searching for specific documents.

The result was a program I call Index. I never used Index on the lawsuit because by the time it was written a manual index had been implemented. Also, I confess that I wasn't eager to dedicate my computer to such a project.

This article deals with my cross-indexing program from many angles. First, possible applications of Index are suggested. After the mechanics of Index are described, alternative indexing systems are discussed. Finally, tips for customization and conversion to other BASICs are presented.

Before we go into Index and its uses, you should know that any name or other information that appears in Index has no relation to any case or matter I have ever worked on, and the views presented in this article are strictly my own.

Applications

In Index I used the following format to describe documents in a lawsuit:

"DOCUMENT# FROM TO DATE "

(Note that DOCUMENT # defines the physical location of a document in a filing system.) For *any* number of documents *—not* limited by amount of RAM—the computer stores the relevant information on tape.

Then, at some later time, the user instructs the computer to retrieve and display, for example, the descriptions (including location) of all letters that were from Smith and were dated August 1976. If the documents were bad checks, the user might want to add a separate category for amount; if so, the computer could also display the sum total of all the bad checks that were, say, written to the order of Jones Corporation in 1977. Index could be very helpful in the preparation of a case for trial.

Although Index was designed for litigation, it can easily be modified for other uses. You non-lawyers could modify it to record your personal checks and display, at the end of the year, those that were tax deductible by category (medical expenses, interest paid, charitable deductions, etc.) or all the checks you made out to your child in college to establish that you paid enough of the child's support for the child to qualify as your dependent on your federal tax return. You might want your computer to cull all of the checks written to the XYZ Department Store in the past six months to see if you really do owe them $9,999.99.

For your personal library of books or records, you might want to retrieve and locate all of Thomas Pynchon's short stories or songs with lyrics by George Harrison. Recipes could be sorted by cooking time and major ingredients. Color slides could be described and sorted by subject matter, date, film type, f-stop, exposure time and lens used; a photographer might want to retrieve all of his or her shots of sunsets taken at f-4.

A pharmacist could determine who had bought more than a certain amount of a highly regulated drug within a specified period. Other possible applications abound.

How Index Works

First, take a look at the two program listings (Programs A and B). You'll see that they're in

Program A. Index.

```
1 REM BY JOHN A. RECORDS, 100 BLEECKER STREET, NEW YORK, NY 10012
5 CLS
7 PRINTTAB(27);"I N D E X":PRINT
10 PRINT"PRESS 1 TO DISPLAY AND SORT DATA--"
11 PRINT"PRESS 2 TO STORE DATA--"
12 PRINT"PRESS 3 TO END PROGRAM--"
15 INPUTY
20 ON Y GOTO990,10000,30000
990 CLS
991 PRINTTAB(22);"DISPLAY AND SORT":PRINT
992 INPUT"NEED HELP WITH SEARCH PATTERN";Z:IF Z=Y GOTO15000
994 PRINT"TYPE '2001' AND YOUR SEARCH PATTERN ('G 3500' ENDS LINE 2001)."
995 PRINT"AFTER LINE 2001 ENTERED, TYPE 'RUN 999' AND PRESS ENTER."
996 PRINT"TYPE 'CONT' AND PRESS ENTER IF SEARCH PATTERN UNCHANGED.":STOP
999 CLS:PRINT:INPUT"PRESS ENTER WHEN DATA TAPE READY TO PLAY";B$
1000 PRINT"DOC.#(A)","FROM(B)","TO(C)","DATE(D,E,F)"
1003 X=0
1005 INPUT#-1,A,B,C,D,E,F
1009 REM TEST FOR END OF DATA: DO B & C=0?
1010 IF (B=0)*(C=0)GOTO5000
2000  REM YOUR SEARCH PATTERN SHOULD BRANCH TO 3500 IF SATISFIED
2001 GOTO3500
3000 GOTO1005
3500 PRINTA,
3510 ON B GOSUB20000,20010,20030,20040,20050,20060,20070
3512 IFBC7GOTO3520
3515 ONB-7GOSUB20080,20090,20100
3520 ON C GOSUB20000,20010,20030,20040,20050,20060,20070
3522 IFCC7GOTO3530
3525 ONC-7GOSUB20080,20090,20100
3530 PRINTD;"/";E;"/";F
```

Level II BASIC, even though I wrote them in Level I. This is because I have no printer and no access to a Level I system with a printer.

However, a professional computer consultant I know, Bob Wine, has a full-blown Level II system for his personal use. Bob generously converted the programs to Level II and gave me a printout—in Level II.

Two significant effects of the conversion from Level I to Level II should be noted. First, and most important, the −1 in lines 1005 and 10110 should *not* be used in Level I. Second, the Level I abbreviations that I used extensively have been expanded, except in PRINT and REM statements. Level I users with 4K RAM should abbreviate to ensure that memory space is not overrun. I have never run the programs in Level II.

Generally, the user describes a series of items—such as documents in a lawsuit, color slides, customers, recipes, etc. —and the computer stores this description on tape, reads back the tape and displays those items that meet the selection criteria set by the user. Take a look at the flowcharts in Figs. 1-3 for a more detailed description of the way Index works.

The operation of the Index can be broken down into two areas: (1) input and storage of data (lines 10000 to 18999) and (2) retrieval, selection and display of data (lines 990 to 5999).

Input and Storage of Data

During input and storage, the computer interrogates the user with respect to the names of the persons the document was "TO" and "FROM" and the date of the document. Numbers corresponding to names are presented as a menu to aid the user.

After each document has been described, the computer outputs the description to a data tape, a short process, and questions the user about the next document. The user responds with a series of zeros if there is no more data and may then select and display data, store more data or end the program. Appropriate prompts are supplied for the use of the tape recorder.

```
1 REM BY JOHN A. RECORDS, 100 BLEECKER STREET, NEW YORK, NEW YORK
2 REM SHORT BUT FAST VERSION OF 'INDEX'.  INSTRUCTIONS ARE LIMITED
3 REM TO SAVE MEMORY FOR DATA STATEMENTS.
99 REM HERE ARE SOME SAMPLE DATA STATEMENTS
100 DATA1,2,2,3,8,9,7,6,"POSSIBLE FORGERY"
110 DATA3,5,6,6,6,9,7,6,"XYZ BANK CHECK"
120 DATA1,2,2,3,6,9,7,1,"PHOTOCOPY"
125 DATA3,5,6,8,9,7,5,23,"EX. #23"
130 DATA0,0,0,0,0,0,0,0,"END OF DATA"
999 CLS
1000 X=0:PRINT"TOPIC(S)","DATE","FROM-TO","COMMENT"
1005 READ A,B,C,D,E,F,G,H,A$
1006 REM A&B STORE TOPICS;C,D&E STORE DATE;F&G STORE FROM-TO;H STORES
1007 REM EX# FOR DECODING;A$ STORES EX#/COMMENT FOR QUICK USER ACCESS
1009 REM ** TEST FOR END OF DATA - LAST DATA ALL ZEROES
1010 IF(C=0)*(D=0)*(E=0)GOTO30000
2000 REM***  PUT SEARCH PATTERN HERE   ***
2001 REM EX - IF(A=1)*(C=6)+(C=7)G.4000. !!ALWAYS GO 4000!!
3000 GOTO1005
4000 PRINTA;",";B;C;"/";D;"/";E;F;"-";G;A$
4005 IF X=13PRINT"PRESS ENTER WHEN DONE WITH THIS PAGE";:INPUTB$
4025 IFX=13GOTO999
4030 X=X+1:GOTO1005
4040 GOTO1005
30000 PRINT"SEARCH ENDED"
```

Program B. Short index.

```
4005 IF X=13PRINT"PRESS ENTER WHEN DONE WITH THIS PAGE";:INPUTB$
4025 IFX=13CLS:PRINT:GOTO1000
4030 X=X+1:GOTO1005
4040 GOTO1005
5000 INPUT"DATA ON TAPE SEGMENT HAS BEEN READ.  IS THERE ANY MORE DATA";Z
5010 IFZ=YPRINT"PRESS ENTER WHEN THE TAPE RECORDER AND TAPE ARE READY";
5020 IFZ=NGOTO5030
5025 INPUTB$:PRINT:GOTO1000
5030 PRINT"DON'T FORGET TO PRESS 'STOP' ON THE TAPE RECORDER."
5040 PRINT:GOTO10
5999 END
10000 CLS:PRINTTAB(30);"STORE":PRINT
10005 INPUT"PRESS 'ENTER' AFTER 'RECORD' AND 'PLAY' KEYS ARE ENGAGED";B$
10010 PRINT:PRINT"NOTE:EXPRESS DATES NUMERICALLY, AND JUST USE LAST 2"
10015 PRINT"DIGITS OF YEAR (EX.: '01,12,78'= 'JANUARY 12, 1978 ').
10016 PRINT"RESPOND WITH ZEROES IF NO MORE DATA."
10017 PRINT"** BE SURE YOU DON'T RUN OUT OF TAPE! **":PRINT:PRINT
10018 PRINT:PRINT
10019 INPUT"WHAT DOCUMENT # DO WE START WITH";A
10020 PRINT"DOCUMENT #";A
10022 GOSUB19000
10030 INPUT"DOCUMENT WAS FROM";B
10031 REM 10032&10045 TEST INVALID 'FROM' AND 'TO'
10032 IFB>10GOTO10030
10040 INPUT"DOCUMENT WAS TO";C
10042 IF(B=0)*(C=0)GOTO10110
10045 IFC>10GOTO10040
10050 INPUT"DATE OF DOCUMENT (RESPOND '0,0,0' IF N/A)";D,E,F
10110 PRINT#-1,A;",";B;",";C;",";D;",";E;",";F
10125 IF(B=0)*(C=0)PRINT"OK-NO MORE DATA":PRINT:GOTO10
10130 PRINT:A=A+1:GOTO10020
14999 END
15000 CLS:PRINT"THERE ARE 6 VARIABLES YOU MAY DEAL WITH IN YOUR"
15010 PRINT"SEARCH ROUTINE:"
15020 PRINT"'A' IS THE DOCUMENT #, AND VARIES BETWEEN 1 AND THE"
15030 PRINT"TOTAL NUMBER OF DOCUMENTS."
15040 PRINT"'B' AND 'C' ARE, RESPECTIVELY, 'FROM' AND 'TO', AND ARE"
15050 PRINT"DRAWN FROM THIS LIST—"
15060 GOSUB19000
15080 PRINT"'D','E', AND 'F' ARE, RESPECTIVELY, MONTH, DAY, AND YEAR."
15090 PRINT"USE THE LOGICAL OPERATORS '*' (AND) AND '+' (OR) IN"
15100 PRINT"LINE 2001 SEARCH ROUTINE (SEE LEVEL I MANUAL CH.24)."
15110 PRINT"FOR EXAMPLE,'2001 IF (B=2)*(F=77)G.3500' WOULD PRINT ALL"
15120 PRINT"DOCUMENTS FROM BEAKITY IN 1977."
15130 PRINT"** REMEMBER--LINE 2001 SHOULD ALWAYS END WITH 'G.3500'**"
15140 INPUT"PRESS ENTER WHEN READY TO CONTINUE";B$
15145 CLS
15150 PRINT"NOW YOU SHOULD ENTER YOUR SEARCH PATTERN IN LINE 2001."
15160 PRINT"AFTER YOU HAVE DONE SO, TYPE 'RUN 999' AND PRESS ENTER."
15170 PRINT"IF YOU WANT TO SEE THE SEARCH INSTRUCTIONS AGAIN, TYPE"
15180 PRINT"'RUN 15000' AND PRESS ENTER.":STOP
18999 END
19000 GOSUB20000:GOSUB20010:GOSUB20030:GOSUB20040:GOSUB20050:GOSUB20060
19010 GOSUB20070:GOSUB20080:GOSUB20090:GOSUB20100
19015 PRINT" "
19020 RETURN
19999 END
20000 PRINT"1.ANDREWS",:RETURN
20010 PRINT"2.BEAKITY",:RETURN
20030 PRINT"3.COGEY",:RETURN
20040 PRINT"4.DOAK",:RETURN
20050 PRINT"5.EDWARDS",:RETURN
20060 PRINT"6.FISHER",:RETURN
20070 PRINT"7.GREEN",:RETURN
20080 PRINT"8.HOPPER",:RETURN
20090 PRINT"9.IAMESCO",:RETURN
20100 PRINT"10.JAMES",:RETURN
30000 PRINT"BE SURE TAPE RECORDER 'STOP' HAS BEEN PRESSED.":END
```

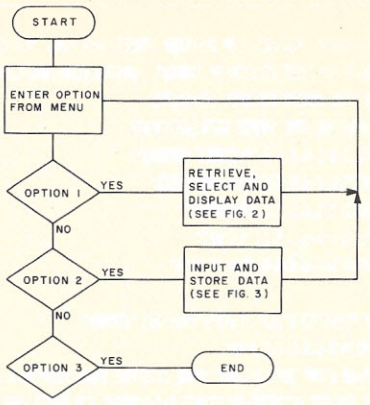


Fig. 1. Flowchart overview.

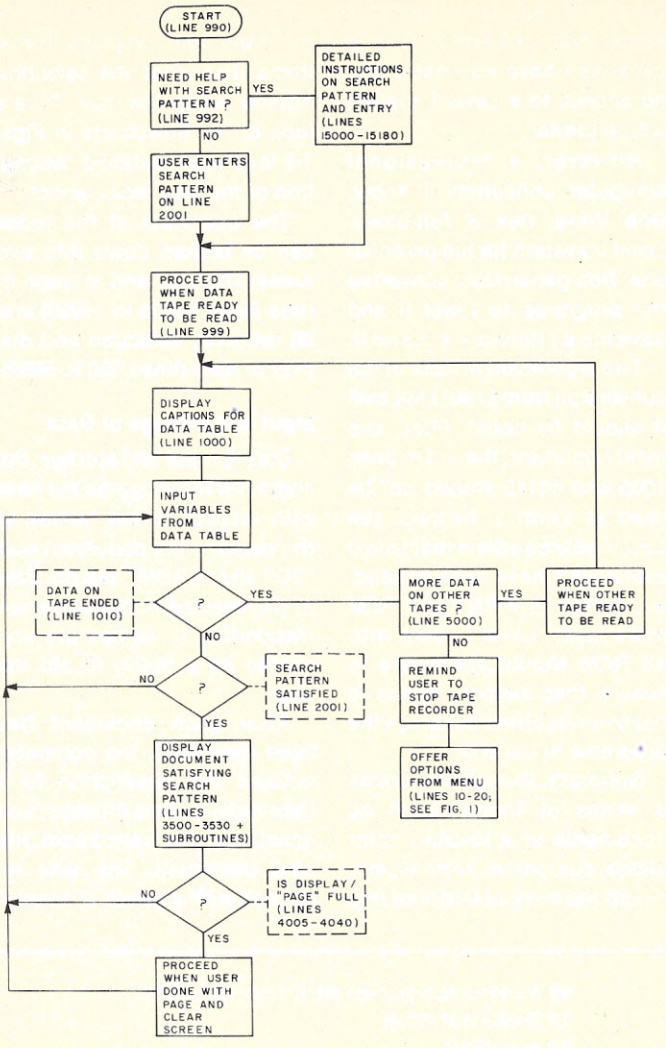


Fig. 2. Flowchart to receive, select and display data.

Retrieval, Selection, Display of Data: Logical Operators

The heart of selection and display by Index are the logical operators "*" (and) and "+" (or). After appropriate prompts on setting up the tape recorder and so forth, the user is invited to enter a "search pattern" on line 2001.

A "search pattern" determines which of the items described by the user will be displayed on the CRT and will ordinarily incorporate one or both of the Level I logical operators; note that line 2001 has been set so that *all* of the documents are displayed. Lines 15000 to 15120 set forth more information on the construction of "search patterns."

The TRS-80 Level I user's manual contains a good treatment of the logical operators. In summary, the "*" (and) is used to link one or more tests, *all* of which must be passed before the computer will, for example, display the description of a document. The "+" (or) is used to link one or more tests, *any* of which may be passed. The "*" and "+" may be used in conjunction.

To help me remember mnemonically that "*" is "and" and "+" is "or," I keep in mind that the word "asterisk" (*) begins with the letter "a," as does the word "and"; therefore, the "plus" (+) must mean "or."

How to Use Index

After you read this article, load and run Index—it will tell you how to use it. Keep in mind that you must create a data tape (input and storage of data) before you can retrieve, select and display data.

As you will see, although the document (or whatever) must be described numerically, the post-selection display of the description may be alphanumeric. Sample runs are not provided as they are not informative.

Advantages, Disadvantages and Alternatives

The main advantage of Index is that it can keep churning through data day in and day out, without attention lapses and without being limited by the amount of random-access computer memory. Also, the computer can manipulate great amounts of data with very little user supervision.

The main disadvantages relate to speed. There is a slight lag on the input of data as the variables are printed on the tape, and a more significant lag as the data is read from the tape and searched. Thus, Index is most useful when time is not critical—for instance, when the user has some other task to occupy him or herself.

In this vein, note that the tape recorder supplied with the TRS-80 has an automatic shut-off at the end of the tape, so that the user may safely leave the computer unattended during data retrieval, search and display. Unsupervised search time could be increased by use of a reel-to-reel tape recorder.

Two faster ways of indexing come to mind. The first is the "In-Memory Information System," available through Radio Shack. This machine-language program runs like lightning, but has no cross-indexing capabilities, unlike Index.

The second faster way of indexing is a compromise between Index and "In-Memory" and is a program much like Index, but using data statements within the program rather than data files on tape.

As you can see from the program listing for Short Index (Program B), its use of the "search routine" is very similar to Index's (Program A). However, in order to maximize the amount of data that can be searched, the program itself must be skeletal. The user could produce a "master tape" with the program on it and use it to produce and record as many search and display programs, each incorporating permanently a block of data, as necessary to accommodate the amount of data to be searched and displayed.

With Index and Short Index, strings A$ and B$ can be used as variables in the display, but they cannot be used for the cross-indexing itself. Disadvantages of Short Index include memory limitations and the need for more user supervision, which, if relatively large amounts of data were to be searched, would eliminate any speed disadvantage the use of data statements would have over the data files.

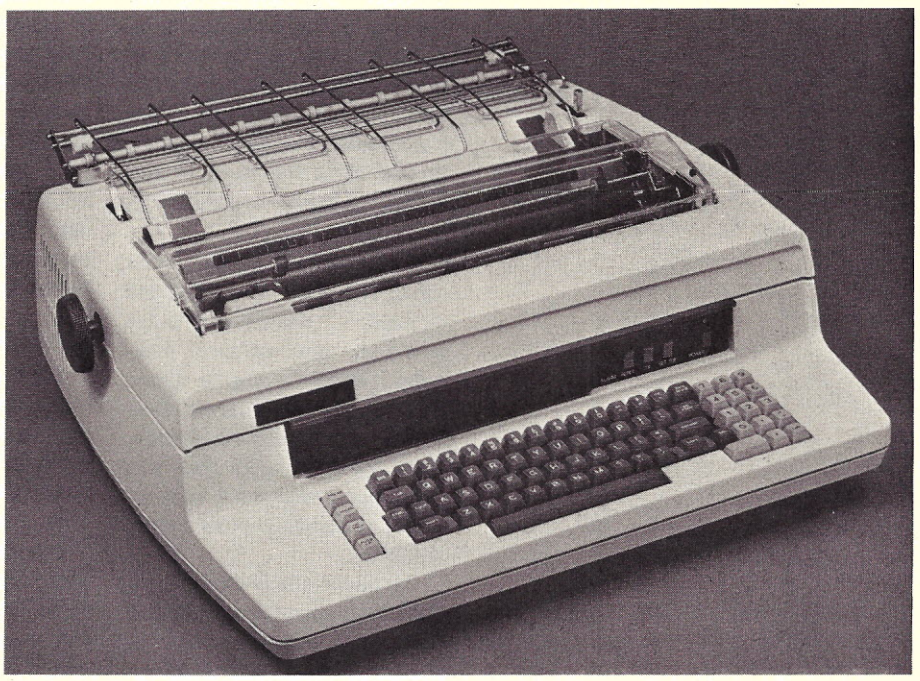
Modifications and Additions

If you're not a lawyer or a litigant, you'll probably want to customize Index. This should be fairly easy with the use of the flowcharts and the following comments.

I think Index increases in usefulness as more variables (the attributes of the item described) are used, since more

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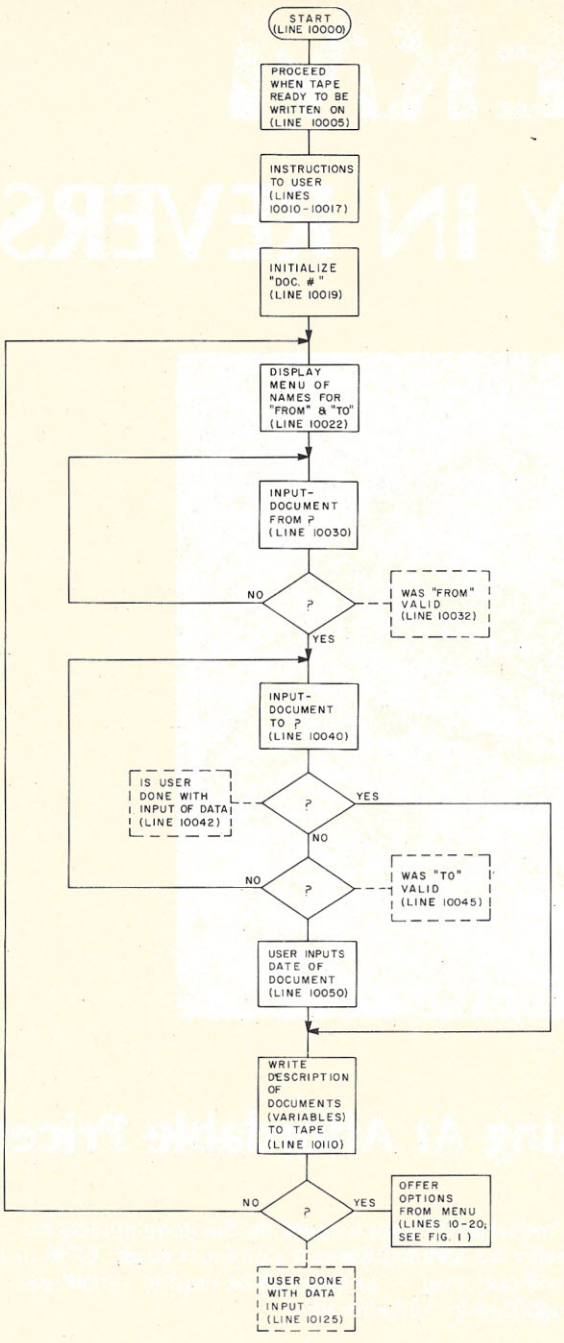


Fig. 3. Flowchart to input and store data.

cross-references are possible. Note, however, that you'll have to pay attention to print formatting if you use too many variables (Index as presented here doesn't have this problem).

If you change the number or names of the variables used to describe the document, color slide or whatever, be sure to make appropriate changes in the following lines: 1000, 1005, 3500 to 3530 (and the subroutines called) and 10019 to 10110 (and the subroutines called). Note that lines 10022 and 15060 call a subroutine beginning at line 19000; this subroutine, in turn, calls subroutines beginning at line 20000 to print out a menu of names for the instructions and user selection during the input and storage of data.

The subroutines beginning at line 20000 are also used by the computer to print out "FROM" and "TO" names associated with the documents selected by the search pattern. These, of course, should be changed and increased in number as is necessary.

A few words about lines 3510 to 3525, which use "ON-GOSUB." Here is how it works: In using "ON-GOSUB," you'll often have more subroutines to go to than will conveniently fit on one line. The TRS-80 begins counting anew on each line on which "ON X GOSUB Y" is used.

You must prevent it from, in effect, repeating the work of any prior line using an "ON-GOSUB" by subtracting the number of related subroutines called previously from the X in "ON X." Thus, the number 7 in line 3515 represents the seven subroutines that can be called by line 3510. The same is true for line 3522 and its relation to line 3520.

Here is a further twist. With Level I BASIC, if in "ON B-7 GOSUB . . ." the value of B-7 is less than zero, an error message ("HOW?") results. Lines 3512 and 3522 prevent this. Subject to memory limitations, there is no reason why you can't use many more subroutines for names or other alphanumerics.

To pack more information onto the display, consider mere numerical representations of the data, which will also cut down the length of the program considerably.

Among other changes you might consider are the elimination of the instructions and the separation of data input and storage and retrieval, selection and display into two separate programs. These changes make more memory available for extensive search routines or, perhaps, a matrix for the storage of the variables attendant to the items selected by your search routine.

You might also want to use a matrix to guard against the use of the same items more than once or to store the descriptions of the selected items on tape. You might want to input the matrix data, once on tape, into a program for the alphabetization or other sorting of the items.

Conversion to Other BASICs

I'm not really conversant with other BASICs and can be of no help to you if you don't have tape data file capability and can't figure a way around it yourself. If you don't have the logical operators "and" and "or," the substitutions shown in Example 1 might be of some help. Note that a colon is used to separate multiple statements on a line.

Conclusion

There you have it—an indexing system with many possible applications, and a little guidance on customizing it. I look forward to implementing Index on a Level II system one day—the advanced string handling and denser data tapes should make the programming easier, the program shorter and the retrieval and selection of data faster. A disk would make it much, much faster . . . I'm sure that Index can be improved, and welcome any suggestions you may have. ■

Acknowledgements I want to thank Murray Adelman of the Radio Shack store on Broadway in New York City. He's unfailingly cheerful and helpful, and I wouldn't buy Radio Shack equipment from anyone but him. Thanks also to Stephanie Nigro, who typed this, and Bob Wine, who provided the program listings.

The Level I statement:

"IF (A = 1) * (B = 2) * (C = 3) GOTO 3500."

might translate into your BASIC as:

"IF A = 1 THEN IF B = 2 THEN IF C = 3 THEN GOTO 3500."

The Level I statement:

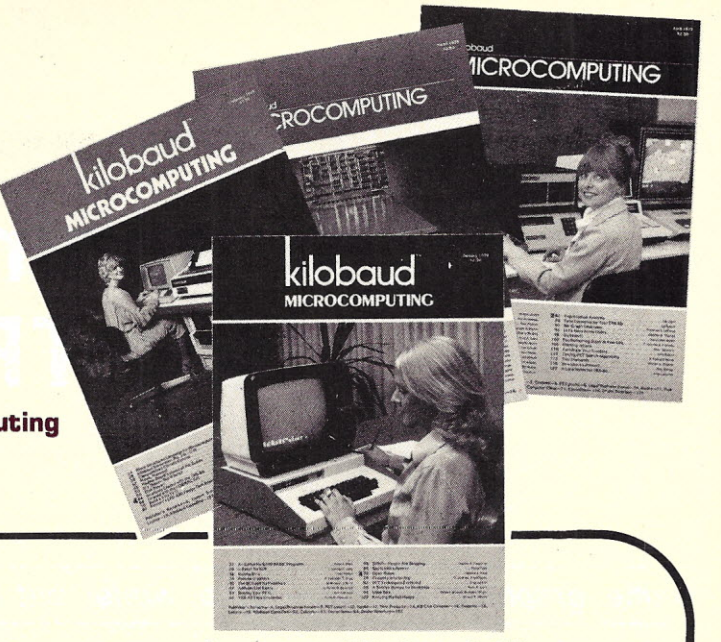
"IF (A = 1) + (B = 2) + (C = 3) GOTO 3500."

might translate into your BASIC as:

"IF A = 1 THEN GOTO 3500
IF B = 2 THEN GOTO 3500
IF C = 3 THEN GOTO 3500."

Example 1.

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Graphing with the TRS-80

Game graphics are OK—for a while, but how about something more substantive?

Curtis F. Gerald
980 West Street
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When you get that new computer system, one of the features that will really turn you on is the graphics display. At least that was the way it was with me when I brought my TRS-80 home from the local Radio Shack store. The merchandiser is smart to supply the blackjack and backgammon games cassette with the basic system.

Although the programming for each of these games is subject to refinement to improve response times, it is more than adequate to illustrate the graphics capability for the low-cost computer hardware. You might wish for a finer resolution of the points that are displayed on the CRT for some applications, but, on the whole, the TRS-80 graphics provide good visual output that can enhance and enliven program responses. The old truism "A picture is worth a thousand words" is valid.

After a few blackjack games against the computer, however, you look for more substantive uses of the graphics. (Some of the challenge is missing when chips are free, because you can always beat the dealer in this game by doubling the bets!)

One of my interests is in solving mathematical problems with a computer. This motivated the following development of programs to draw graphs of mathematical equations. A graph is of value to show the behavior of the function, its points of maximum and minimum, its crossings of the x-axis (the "zeros" of the function) and other points of exceptional behavior.

Everyone at some point in his schooling has had to draw graphs, so the general plan is obvious: (1) Draw the coordinate axes, (2) graduate these with values of x and y (which involves a proper choice of scale factors so an appropriate range of values is presented), (3) compute points (x,y) for the given function, (4) plot the points and (5) sketch a smooth curve through the points. As a homework assignment, this becomes a tiresome chore and is frequently beset with errors.

Of course, this is exactly the kind of thing a computer does well, so a program to facilitate the drawing of graphs is a valuable piece of software. Students should find the programs presented here helpful in their homework. Of course, if you don't have the screen printer (whose $599 price tag equals that of the computer system itself!), you may have to hand in a photograph of the screen to complete your assignment.

The evolution of the final program is shown in steps below. Too often software articles show only the final product. You can learn more from a step-by-step development as given here.

Drawing the Axes

The first step is to draw the coordinate axes. This is easy as soon as we understand the commands that clear the screen

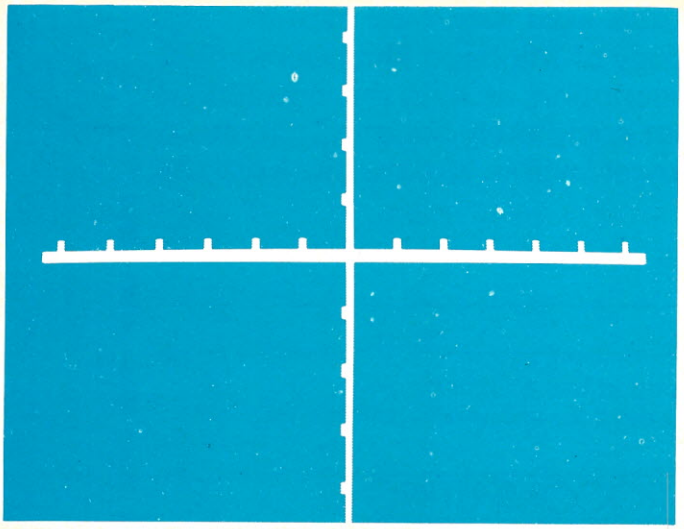


Photo 1. Coordinate axes with tick marks.

```
  5  REM SET UP GRID AFTER CLEARING SCREEN
 10  CLS
 20  FOR X=0 TO 127
 30  SET(X,23)
 40  NEXT X
 50  FOR Y=0 TO 47
 60  SET(63,Y)
 70  NEXT Y
 80  REM ADD TICK MARKS
 90  FOR X=3 TO 127 STEP 10
100  SET(X,22)
110  NEXT X
120  FOR Y=3 TO 47 STEP 5
130  SET(62,Y)
140  NEXT Y
150  GOTO 150
```

Program A.

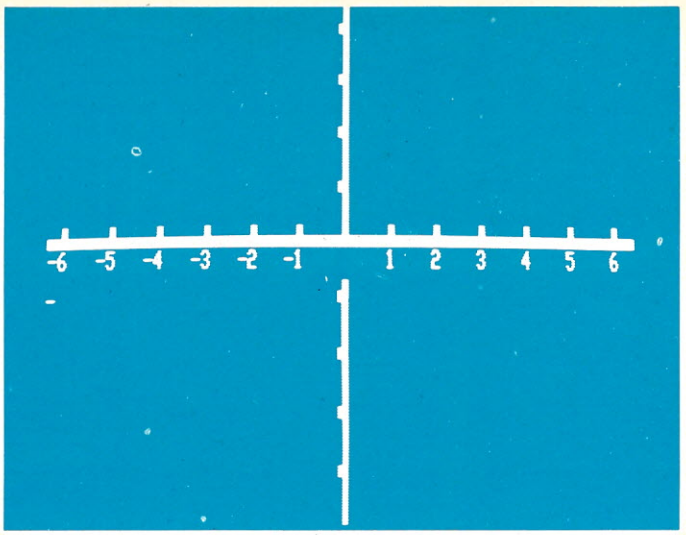


Photo 2. When labels are printed along the x-axis, part of the y-axis is destroyed.

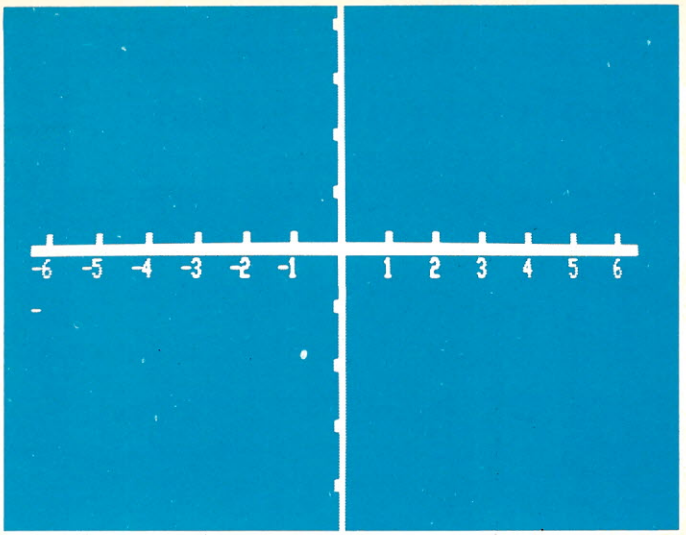


Photo 3. The y-axis is complete when it is drawn after x labels are written.

(CLS) and that light up a single point (SET(X,Y)). We need to know how the points are numbered. Fig. 1 shows the numbering system for points.

X values, which denote the left-to-right location, run from 0 to 127. An x value of 63 is at the center. (Actually, the center is at 63 1/2, but we can't split the displayable points.) Y values, denoting top-to-botton locations, run from 0 to 47; y = 23 is at the center line.

Program A shows how we draw the axes and center them on the CRT. The resultant display is shown in Photo 1.

The purpose of the endless loop in line 150 is to avoid a "READY" prompt that would otherwise come after the program finished. This would wipe out part of the axes that were drawn on the screen.

Labeling the X-Axis

An addition to the axes that makes them look better, I feel, is to label the tick marks with the corresponding values of the x variable. For reasons that become clear later, we don't label the y-axis. Before we can add to the program to do this, we must understand how to print at specified locations on the screen.

TRS-80 BASIC includes a PRINT AT command with this capability. The locations are specified for the PRINT AT command in a different way than for the SET command, however.

Fig. 2 shows that the screen is divided into 16 lines, each with 64 locations. Locations are numbered successively from upper left, across the screen (the first line running from 0 to 63), then continuing on the second line, from left to right, then the third line, and so on.

To locate x values below the x-axis, we see we want values from −6 to −1 displayed at character locations from 512 to 537 with steps of 5, and values from 1 to 6 displayed at locations 547 to 572, again with steps of 5. To do this we add the lines in Program B to Program A.

It looks as though we could combine both loops into one by replacing lines 190 to 210 with

```
175  PRINT AT (542 – X•5), – X
```

but there is a flaw when this is done. We find that the PRINT AT command fills the entire line to the right of its location, so earlier characters are wiped out by later ones if we use the PRINT AT command with locations running backwards on the same line.

Executing the expanded program (Programs A and B) gives the results shown in Photo 2. Obviously something is wrong;

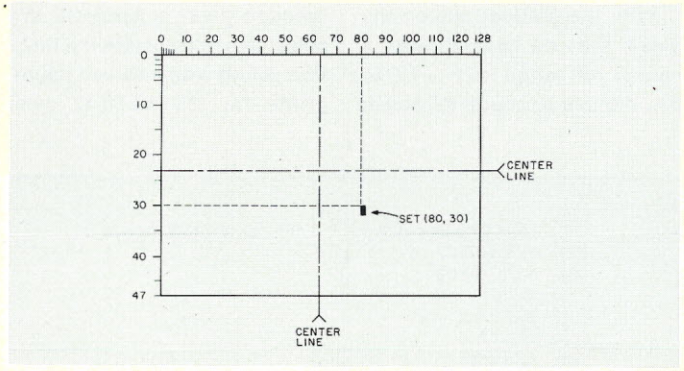


Fig. 1. Numbering scheme for the SET command. X values can vary from 0 to 127, and y values from 0 to 47. The point shown is lighted in response to SET (80,30).

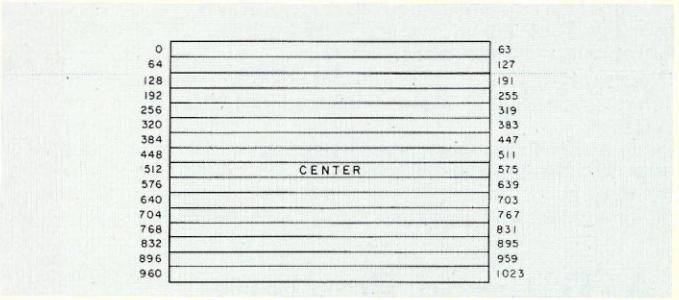


Fig. 2. Numbering scheme for PRINT AT command. The position for the start of printing is given by.a single value ranging from 0 to 1023. The screen accommodates 16 lines. Numbers from 0 to 63 designate positions in the first line; 64 through 127 designate positions on the second line, etc. The word CENTER is shown as it would be displayed in response to PRINT AT 542, "CENTER." If points on the same line had been SET prior to the PRINT AT command, all of these points to the right of position 542 would be cleared.

```
150  REM LABEL THE X TICKS FROM – 6 to 6
160  FOR X = – 6 TO – 1
170  PRINT AT (542 + X•5),X
180  NEXT X
190  FOR X = 1 TO 6
200  PRINT AT (542 + X•5),X
210  NEXT X
220  GOTO 220
```

Program B.

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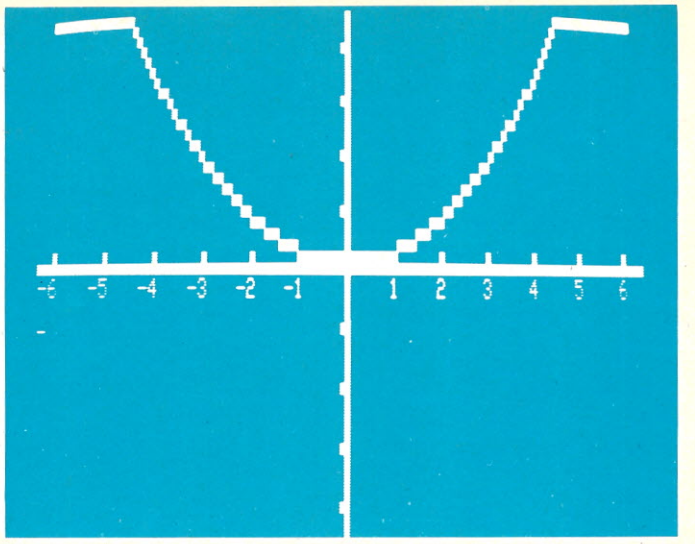


Photo 4. Graph of the function $y = x^2$, the output from Program D.

part of our y-axis is destroyed during the labeling step. The wipeout caused by the PRINT AT command is responsible; printing the label for $x = -1$ overlays some of the y-axis with blanks.

Recognizing the cause, of course, suggests the cure. All we need do is renumber lines 50 to 70 so they are executed after line 210. When this is done, we get the output shown in Photo 3.

Plotting Points

Our next step, after drawing the axes and graduating them, is to compute the points and plot them. Since we have a computer to do the work, there is no need to be stingy with computations. In fact, if we calculate values for every x value that corresponds to a horizontal position from 0 to 127, they should be close enough together so that no curve needs to be sketched to connect them.

With the graduations on the x-axis that we have chosen, x values will range from -6.3 to 6.4. We use a loop to establish values for x, calling a subroutine to compute the corresponding values of y. The loop, with the subroutine beginning at line 1000, is shown in Program C.

Because of the endless loop at 280 (which suppresses a "READY" prompt that would wipe out part of the display), we have to terminate execution with the BREAK key. Note that we cannot use X to control the loop, for Radio Shack Level I BASIC does not allow other than integers as the STEP value.

Now we need the subroutine at line 1000. If the function is a simple polynomial (involving only integer powers of x), there is no problem. Functions of logarithms, exponentials or trigonometric relations are not as straightforward. The user's manual for Level I BASIC gives subroutines that can be called to compute such quantities.

Suppose we try the simple function $y = x^2$, a parabola. We shall have to translate the function values into y values appropriate for the SET(I,Y) com-

```
220  REM THIS IS A FOR/NEXT LOOP TO COMPUTE Y = F(X)
230  FOR I = 0 TO 127
240  X = (I - 63)/10
250  GOSUB 1000
260  SET (I,Y)
270  NEXT I
280  GOTO 280
```

Program C.

```
  5  REM SET UP GRID AFTER CLEARING SCREEN
 10  CLS
 20  FOR X = 0 to 127
 30  SET(X,23)
 40  NEXT X
 80  REM ADD TICK MARKS
 90  FOR X = 3 TO 127 STEP 10
100  SET(X,22)
110  NEXT X
120  FOR Y = 3 TO 47 STEP 5
130  SET(62,Y)
140  NEXT Y
150  REM LABEL X-TICKS FROM  -6 TO 6
160  FOR X = -6 TO -1
170  PRINT AT (542 + X*5),X
180  NEXT X
190  FOR X = 1 TO 6
200  PRINT AT (542 + X*5),X
210  NEXT X
214  FOR Y = 0 TO 47
216  SET(63,Y)
218  NEXT Y
220  REM THIS IS A FOR/NEXT LOOP TO COMPUTE FUNCTION VALUES
230  FOR I = 0 TO 127
240  X = (I - 63)/10
250  GOSUB 1000
260  SET(I,Y)
270  NEXT I
280  GOTO 280
1000 Y = X*X
1010 Y = INT(23 - Y)
1020 IF Y<0 THEN Y = 0
1030 IF Y>47 THEN Y = 47
1040 RETURN
```

Program D.

mand of line 260 so that when y = 0, we plot at the y point 23. It is also necessary to force an integer value because the SET command requires integer arguments. We thus write the following:

```
1000  Y = X*X
1010  Y = INT(23 - Y)
1020  RETURN
```

When we try this, we discover something else about the SET command—negative values aren't permitted either. Values for the x position greater than 127 and for y greater than 47 are allowed. In these cases, the point is plotted as if the screen wrapped around from right to left and from bottom to top. In mathematical terms, the position values are calculated for x modulo 128 and for y modulo 48.

For our graph it seems simpler to put any y values that are too large or too small to be plotted at the correct x point, but at the extremes of the screen, either at the top or at the bottom. We modify our subroutine accordingly. The program is shown in Program D; the corresponding display is shown in Photo 4.

Program Refinement

Although Program D can draw graphs of various functions by changing the definition in the subroutine in line 1000, it is certainly subject to improvement. We would often like to change the scale factor for y so we could either stretch the graph vertically or compress it. This will allow us to quickly examine interesting features of the graph.

It is easy to add this feature; all we need do is multiply the y values by the scale factor. It is convenient to have the scale factor an input value. Having an adjustable scale factor for y is the reason we omitted putting values as labels for the ticks on the y-axis.

When we rescale the y axis, the interval between ticks on that axis ought to be displayed. (When the scale factor is unity, the ticks are at intervals of 5.) A PRINT AT command can do this for us. It would be best to print near the bottom of the graph to avoid blanking out part of the display.

Other features of common interest, especially when the maximum and minimum points

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```
1 REM PROGRAM FOR GRAPHING ON TRS-80
2 REM    C . F. GERALD, JUNE 1978
3 REM VARIABLES USED:
4 REM    X - INDEPENDENT VARIABLE
5 REM    Y - DEPENDENT VARIABLE, Y = F(X)
6 REM    M - MAXIMUM VALUE OF Y
7 REM    L - MINIMUM VALUE OF Y
8 REM    R - RANGE, MAXIMUM VALUE OF X THAT IS PLOTTED
9 REM    S - SCALE FACTOR FOR Y
10 REM
11 REM THE FUNCTION IS DEFINED BY A SUBROUTINE AT LINE 1000
12 REM
13 REM INPUT VALUES FOR RANGE, SCALE
20 IN."RANGE FOR X, SCALE FACTOR FOR Y";R,S
30 CLS
35 REM DRAW THE AXES WITH TICK MARKS
40 F.X=0 TO 127:SET(X,23):N.X
50 F.X=3 TO 127 S.10:SET(X,22):N.X
55 REM SUBROUTINE AT 500 NORMALIZES RANGE AND GETS STEP
56 REM   FOR X-LABELS.  A=MAX LABEL VALUE, T=STEP.
60 GOSUB 500
70 F.X=-6 TO 6:P.A.(542+X*5),-A:A=A-T:N.X
80 F.Y=0 TO 47:SET(63,Y):N.Y
90 F.Y=3 TO 47 S.5:SET(62,Y):N.Y
95 REM INITIALIZE M AND L
100 M=-1.E6:L=1.E6
105 REM THE LOOP AT LINE 110 DOES THE PLOTTING
106 REM   FROM -R TO R, BUT ONLY FOR INTEGER SET POINTS.
107 REM   THE SUBROUTINE AT LINE 1000 COMPUTES F(X).
110 F.I=INT(63-10*R)TO INT(63+10*R):X=(I-63)/10*T:GOSUB 1000
120   SET (I,Y):N.I
125 REM PRINT VALUE OF Y-INTERVAL BETWEEN TICKS
130 P.A.945,"Y INT =";5/S
135 REM THE ENDLESS LOOP AT 140 AVOIDS A "READY" PROMPT
140 G.140
495 REM THIS SUBROUTINE NORMALIZES THE RANGE AND GETS
496 REM   THE STEP VALUE FOR X-LABELS.
500 T=1:A=6
510 IF R<6.4 T.530
520 R=R/2:T=2*T:G.510
530 A=6*T:RET.
995 REM THIS SUBROUTINE COMPUTES Y=F(X), RETURNS AN
996 REM   INTEGER VALUE FOR Y APPROPRIATE FOR SETTING
997 REM   THE POINT ON GRAPH.  IT ALSO PUTS MAXIMUM
998 REM   AND MINIMUM VALUES OF Y INTO VARIABLES M AND L.
1000 Y=1/(X*X-X-5)
1010 IF Y>M T.M=Y
1020 IF Y<L T.L=Y
1030 Y = INT(23-S*Y)
1040 IF Y<0 T.Y=0
1050 IF Y>47 T.Y=47
1060 RET.
1070 END
>
```

Program E.

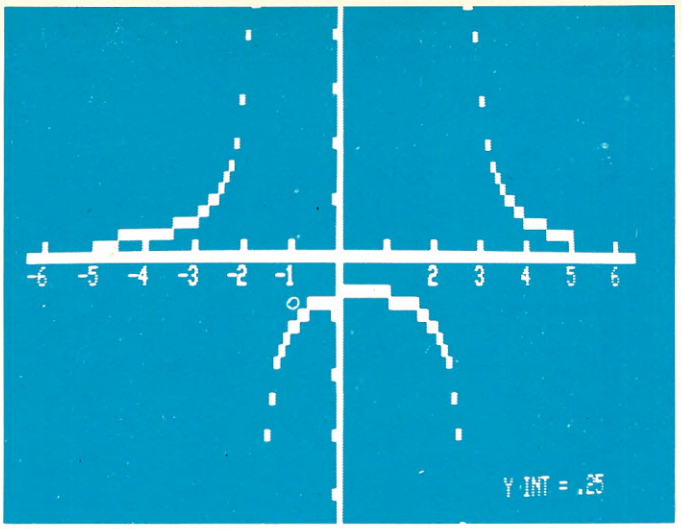


Photo 5. Output from Program E. The range specified was five, and the scale factor was 20.

aren't shown by plotted points, are these largest and smallest y values. So we will plan to store the maximum and minimum values of y as they are computed in the subroutine. If we display these also, it will crowd the output, so we plan to just keep the values in memory, letting the user call for the values when he wants them, using the immediate mode.

The x values that are handled also ought to be restricted to the range from -6.3 to 6.4. We also plan to treat this as an input parameter along with the scale factor for y. It will be necessary to normalize the range, however, so we can label the tick marks along the x-axis with integral values. Accordingly, we decide to adjust the input value for the range so the ticks on the x-axis correspond to integers that are powers of 2.

All these features are incorporated in the final version of the program as shown in Program E. This program also uses the Radio Shack abbreviations for commands, and multiple statements are stacked on the same line. (This considerably reduces the memory space to store the program.)

Remarks in Program E should help to make the program clear. Line 20 inputs the ranges for x values and the scale factor. Lines 30 through 90 draw the axes and label the ticks along the x-axis. A subroutine at line 500 finds the step for the label values by successively dividing the range and doubling the step (which is unity for a range of 6), stopping when the range has been normalized to a value less than 6.4.

The FOR/NEXT loop in lines 110 and 120 does the actual plotting, starting with a set point in the x direction that is equivalent to the negative of R. The function-evaluating subroutine at line 1000 is called before each point is plotted.

The function that is used as an example in Program E and Photo 5 is $y = 1/(x^2 - x - 5)$. When the denominator is zero, the value of y is undefined, of course. For the range that was input for Photo 5, $R = 5$, none of the plotted points occur when the denominator is zero, which happens at $x = -1.79129$ and $x = 2.79129$. If the function ever evaluates to an undefined y value, the program will terminate with an error message; you should guard against this by a test for a zero denominator when other functions are used.

Within the subroutine at line 1000 are statements that store the largest y value in variable M and the smallest in L. We expect the user to request these values by a PRINT command in the immediate mode if he desires to know them. Lines 1040 and 1050 set the y value to plot at the extreme top or bottom of the screen if the computed value of y is too large or too small for normal plotting. Photo 4 shows this feature most clearly.

When the user wants to magnify the vertical scale of the graph to make points near the x-axis more clearly visible, he should input a larger value for the scale factor. For the display in Photo 5, a scale factor of 20 was used. The program prints out the distance between y ticks by the PRINT AT statement in line 130.

By specifying location 945 for this, the value is displayed near the lower right of the screen so as not to interfere with the graph. With this information, the user knows that the maximum in y that occurs near $x = 0.5$ is about $y = -0.2$.

Conclusion—Abbreviations and Picture Pointers

The Radio Shack abbreviations for the commands are shown in Table 1.

Note about the photographs: You can easily make photographs of the screen with a Polaroid camera. The photos here were made with a Model 100 Automatic with a #583 Close-up Kit. The distance from screen to front of lens was 10 3/4 inches. The camera was supported on blocks 6 3/8 inches high. Type 107 film was used at the indoors-without-flash setting, normal position for light/dark setting. The room was darkened, and only light from the screen was present. The screen intensity was normal for eye viewing. ■

PRINT	P.	STEP	S.
THEN	T.	GOSUB	GOS.
GOTO	G.	RETURN	RET.
INPUT	IN.	SET	S.
FOR	F.	PRINT AT	P.A.
NEXT	N.		

Table 1.

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An All-in-One Interface

That's how this author sees George Morrow's cassette/general-purpose interface.

David A. Busse
1510 W. Dempster #210
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When my wife, Diane, and I finished building our Altair, we had a processor and some memory but no way to get whatever we decided to process in or out. We decided that we needed a fairly flexible I/O board at as little cost as possible (sound familiar?).

What we wanted in an interface were: a serial port to communicate with a terminal; at least 4800 baud as a maximum transfer rate; a cassette tape port, or two, to allow file updating (Kansas City standard or Tarbell were those about which we had heard the most so we felt we should have one of those . . . if for no other reason than to increase the likelihood of exchanging software ideas with other fellow travelers in personal computing); a parallel port for use with a paper-tape reader.

And, of course, there was the price tag to consider. This marvel of engineering was to cost as little as possible and still run flawlessly from the moment the old soldering iron was lifted from the last trace (sure!).

Choosing the Interface

Having identified our needs, we started looking around for a product to fill the bill. We soon realized that a single board for each function would be more than we could afford to put into our home computer. We limited our search to "universal" or "general purpose" or multiple" I/O boards. As far as I can tell, all these terms are used to describe a board that has more than one function on it.

Table 1 is a reasonably accurate listing of the different products we discovered. I'm sure it is by no means complete, but it does list the features of each board that we found of interest.

After we complied this list from manufacturers' literature, it seemed that the "Speakeasy" cassette/general-purpose interface by Morrow's Micro-Stuff was the most cost-effective.

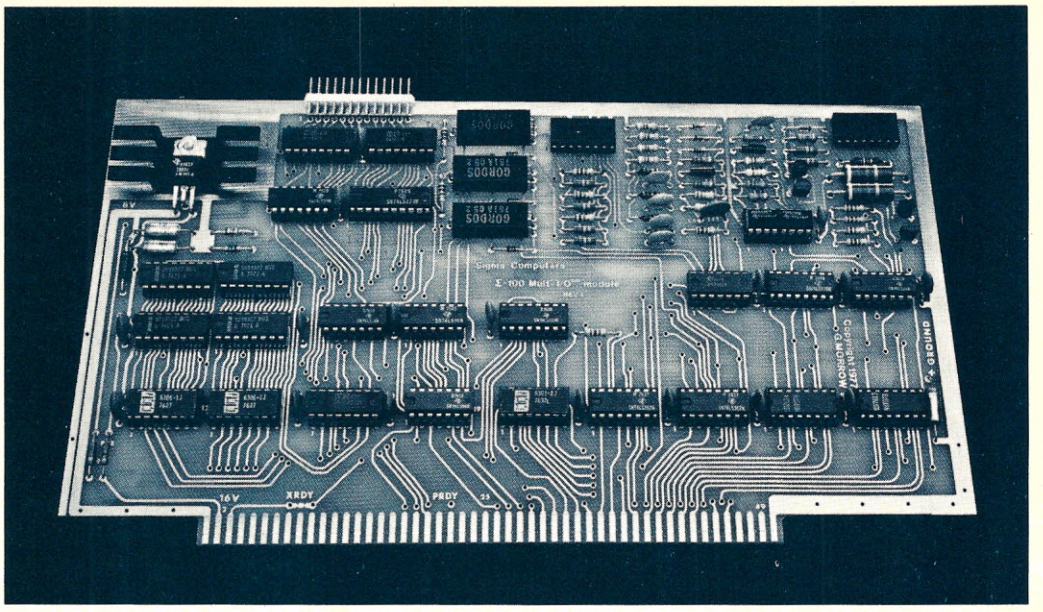
Does this mean that we ran out to one of our friendly local computer stores and slapped down some of our hard-earned money? No sir! Instead, we invested a little money in ordering a copy of the documentation. I recommend this approach to anyone buying any piece of gear. If the documentation is good, it can tell you all sorts of interesting things, such as will it run on *your* 8080 (or whatever) processor and, if so, will it really do what you want without extensive modification, etc.? If the documentation seems poor, can you really afford to buy the widget?

Sure, you're a kit-wizard and can put anything together from half a schematic, but if the little

	Universal I/O Dajen	Speakeasy Morrow	3P + S Processor Tech	CI-812 PerCom
Serial Port:				
Number of ports	1	1	1	1
Speed	20-19200 baud	110-4800 baud	35-9600 baud	300-9600 baud
RS-232	yes	yes	yes	yes
Cassette Port:				
Number of ports	2	3	0	1
Speed	520-41000 baud	300 baud	-	300-2400 baud
Encoding	Bi-phase KC	Bi-Phase KC	-	Bi-phase KC
Motor Control	yes	yes	-	yes
Parallel Port:				
Number of ports	3	1	3 1 as control	-
Software	optional	On-board ROM 512 bytes	-	-
RAM on board	256 bytes	512 bytes	-	-
Power usage	?	700 mA	100 mA	?
Kit cost	$235	$120	$149	$90

Note: The letters "KC" stand for Kansas City compatibility.

Table 1. A list of general-purpose I/O boards and their features.



The Speakeasy I/O interface. (Photo courtesy of Morrow's Micro-Stuff, Albany CA.)

jewel "goes south," wouldn't it be nice to have a list of debugging tips or at least a phone number with a friendly, helpful voice at the other end? So we sent off our five dollars for a documentation package.

Board Description

We received the documentation in about two weeks. It described the interface as having a serial port (RS-232 or TTY), three cassette ports with motor control and a parallel port, 512 bytes of ROM containing software to drive the board and 512 bytes of scratchpad RAM. The serial port has a range of 110 baud to 2400 baud. The on-board firmware in that ROM simulates a UART (more about firmware later).

The parallel port has eight data lines and four status lines. The cassette ports each have a Gordos relay to provide motor control. Each port reads or writes Kansas City standard at 300 baud. The memory on the board is addressed from 8000 hex to 81FF hex for the ROM and 8200 hex to 83FF hex for the RAM. The ROM contains what is referred to as the COPE (cassette operating executive) routines.

On-board Software

There are 10 routines in all. To handle a cassette you can call a COPE subroutine that will start the motor on the cassette drive attached to a specified port; via arguments passed in registers, the routine will read, write, verify or skip a block of data of a specified length, then optionally stop the motor. Notice that blocks of data are operated upon. I'll provide some examples later.

There are three user routines related to serial I/O. The first is DETCT. This routine is started from the front panel and waits for a carriage return to be typed in. From that input the baud rate of your terminal is determined and recorded in a reserved location in the on-board RAM for the INPUT and SROUT subroutines. These two routines are used for serail INPUT and OUTPUT, respectively. The INPUT routine, for example, has an option to echo the input.

There are two other user subroutines: BOOTS and CHECK. BOOTS is a routine that allows you to bootstrap the first cassette drive by entering the address of BOOTS on the front panel (815F hex) and hitting run. The routine then will read the first block of 256 bytes off cassette port #1 into the on-board RAM at location 8200 hex, then stop the cassette and jump to that address. You could write quite a bootstrap routine in 256 bytes.

The CHECK routine is a user-callable subroutine that will calculate a check digit for a buffer of data. The intent of the routine is to help with error detection when reading data off cassette.

The documentation contains a suggested record format for cassette tape that includes a check digit field. After reading such a record, your program calls CHECK while passing the address and length of the record, and CHECK passes back a check digit, which you then compare to the one read in. The procedure is altered appropriately for writing records.

There are some additional routines used internally to generate waveforms for cassette I/O, etc. If you use all the routines, these chips will save you 1K of user memory.

The Documentation

At this point I would like to give you a better idea of what the documentation includes. First of all, there are the assembly instructions. These are not as detailed as many beginners' kits. In fact, the whole assembly-instruction section only takes two pages.

This kit is not for a beginner. The advertisements we saw for the board made this quite clear. It is assumed, for example, that you will recognize ICs Z16, Z17 and Z20 as MOS ICs and know enough to handle them properly to avoid static electric shock damage. It is also assumed that you will be able to identify and read the values of resistors, capacitors, diodes, etc.

Next in the documentation is the parts list. This list has some additional notes to help you identify parts. Then come the hardware notes. This section discusses theory of operation and gives some advice on what type of cassette recorder to use ($35-to-$50 range with good frequency response and good tape).

The software-notes section follows and explains each routine included on the ROM. Commented assembly listings for each routine, as well as a memory map for the routines and

```
STMNT     LOC     OBJECT CODE       SOURCE STATEMENT

    1                               *
    2                               * TEST OF THE INPUT AND OUTPUT PORTS ON THE BOARD
    3                               *
    4
    5     000000                          ORG     0
    6     000000    333 005               IN      05          ;READ
    7     000002    323 005               OUT     05          ;WRITE
    8     000004    303 000 000           JMP     0           ;AGAIN FOREVER
    9                                     END

  0 ERROR(S) DETECTED DURING PASS 1
  0 ERROR(S)          DETECTED DURING PASS 2
```

Program A. The basic serial port test.

the scratchpad RAM, are also included.

What follows are several pages discussing how-to-use tips for each of the types of ports. Also included is a schematic and a board layout showing the position and orientation of each part on the board. Last, there is an 8 x 10 photograph (see accompanying photo) of the assembled board.

Construction

The board provided has plated-through holes and gold contacts. No heat-sink paste or solder is included in the kit (again, assumptions have been made concerning kit-builders' experience). Since Diane and I had just finished building our computer and because I had been doing some other kit building in the past, this was no problem. All the integrated circuits have sockets provided for them. In fact, our kit came with one extra circuit (which promptly found a home in our spare parts box).

The ROM chips must go into their proper positions on the board. Sure all three chips are the same type, but they have a program in them, remember? So how do you get the right chip into the right place?

On the back of each chip is a piece of tape with a number on it (16, 17 or 20). These numbers correspond to the part numbers Z16, Z17 and Z20 as illustrated in the board diagram. That is about the most complicated part of the board assembly, i.e., making sure you don't goof putting in the memories. You should also refer to the board diagram to get the right orientation for diodes and transistors.

The board went together in a few hours with no problems. There are plenty of bypass capacitors, and the layout of parts seems logical enough. There was a "Power-Ground short circuit test" described in the instructions, and the board passed that. We could see no defects in the board, so we plugged it in and turned on the computer.

Testing the Board

Because this board has many functions, we had to come up with several tests. It passed the smoke test the first time. Then we turned off the power and attached the cables we had made to the serial and cassette ports. We turned on the computer again and got smoke! Resistor R39 burned out and had to be replaced.

"Why?" you ask. Well, according to the hardware notes, if you wish to use the RS-232 option with your serial port, the TTY inputs must be shorted. I managed to cross the inputs and outputs, thus the smoke. I corrected the problem (the correct modification is to tie "TTY Input +" to "TTY Input −" (3J3 to 3J4)), and we had no more problems.

In order to run further tests we needed to have our cassette and CRT attached via the cables I mentioned above. These two ports go off the board by means of two 16-pin sockets. (The parallel port used a 26-pin plug connector.) We used ribbon cable and DIP headers to go from the board to the back of the computer chassis.

After some corrrespondence, both by phone and mail, with Morrow's Micro-Stuff, we developed some text routines and some general-purpose I/O routines. This is not to say that the documentation provided does not accurately describe how to use the board. It does imply that I don't always write perfect software. At one point we returned the board along with a test routine which we couldn't get to work. We got the board

```
STMNT     LOC     OBJECT CODE       SOURCE STATEMENT

    1     000000                          ORG 0
    2                                     *
    3                                     * THIS TESTS THE INPUT ROUTINE PROVIDED ON THE BOARD
    4                                     * BY SETTING THE ECHO OPTION.  IF THE CHARACTER
    5                                     * TYPED IN IS ECHOED, THEN THE ROUTINE IS AT LEAST
    6                                     * RECIEVING AND TRANSMITTING CORRECTLY.
    7                                     *
    8
    9     000000                          INPUT:  EQU 0         ;MY ASSEMBLER WILL NOT HANDLE
   10                                                          ;ADDRESSES ABOVE 32K SO THIS
   11                                                          ;SYMBOL WILL HAVE TO BE PATCHED
   12                                                          ;TO 157 201 (SPLIT OCTAL) EVERY
   13                                                          ;WHERE IT OCCURS.
   14
   15     000000     061 000 002           LXI   SP,10000     ;SET UP STACK
   16     000003     006 000               MVI   B,0          ;TELL INPUT TO ECHO
   17     000005     315 000 000           CALL  INPUT        ;GO GET IT
   18     000010     303 005 000           JMP   *-3          ;LOOP BACK
   19                                      END
```

Program B. Test of the INPUT routine and its echo option.

```
STMNT     LOC     OBJECT CODE       SOURCE STATEMENT

    1                                     *
    2                                     * THIS TEST USES THE INPUT ROUTINE TO GET A CHARACTER
    3                                     * OFF THE TERMINAL THEN STORES IT AT LOCATION 17 OCTAL.
    4                                     * IF THE CHARACTER YOU TYPED IN APPEARS AT 17 OCTAL
    5                                     * INPUT WORKS.
    6                                     *
    7
    8     000000                          INPUT:  EQU   0
    9
   10     000000     061 000 002           LXI   SP,10000     ;SET UP STACK
   11     000003     006 001               MVI   B,1          ;DO NOT ECHO
   12     000005     315 000 000           CALL  INPUT        ;GO GET CHARACTER
   13     000010     041 017 000           LXI   H,170        ;SET MEMORY POINTER TO 170
   14     000013     162                   MOV   M,D          ;PUT CHARACTER RETURNED
   15                                                          ;FROM INPUT INTO 17
   16     000014     303 014 000           JMP   *            ;WAIT HERE
   17                                      END
```

Program C. Test of the INPUT routine to check storage of character keyed in.

```
STMNT     LOC     OBJECT CODE       SOURCE STATEMENT

    1                                     *
    2                                     * THIS ROUTINE TESTS THE SROUT ROUTINE.  IF IT WORKS
    3                                     * A STRING OF "1"S SHOULD PRINT OUT ON THE TERMINAL
    4                                     *
    5     000000                          SROUT:    EQU  0            ;PATCH THIS SYMBOL TO
    6                                                                 ;263/201 SPLIT OCTAL
    7     000000     061 000 002                LXI  SP,10000     ;SET UP STACK
    8     000003     076 061          AGAIN:    MVI  A,61O        ;A REG  <-- "1"
    9     000005     315 000 000                CALL SROUT        ;OUTPUT THE ONE
   10     000010     303 003 000                JMP  AGAIN        ;LOOP BACK
   11                                           END
```

Program D. Basic test of the SROUT routine.

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back within two weeks with a note stating that the board checked out. The note also gently pointed out the error in my test routine responsible for the erroneous results.

Program A tests the serial port hardware. When the program is running, every character typed in should be echoed back to your terminal. We are using a Heathkit H9 terminal running at 600 baud (although this test is insensitive to baud rate) and set to full duplex. If your terminal is set to half duplex you'll get a double echo—one from your terminal and one from the line.

Program B tests the INPUT routine in the on-board ROM. Before running it, you must set the baud rate constant on the board by using the DETCT routine I mentioned earlier. When running, it should give the same results as the first program, only this time we are testing the INPUT routine's ability to read and write to the port (due to the use of the echo option).

Progam C tests the INPUT routine further. I suggest examining the memory location through the front panel after depressing a key on the terminal.

Program D tests the SROUT routine in a fashion similar to that of Program C. Again you need to use the front panel of your machine in running the test.

Program E tests the cassette software. It will also give you an idea of how you set up a call to get the COPE software to read or write cassette. The test involves setting up a 10-character block to write and then read back from tape.

Program F is an example of how to use the serial routines in a more general way. These routines could be patched into your monitor or BASIC interpreter to allow it to use the Speakeasy board. Of most interest might be the RDLN and WRLN routines. When implemented, they allow the programmer to deal with strings (one or more characters followed by a carriage return, null or line feed, instead of individual characters).

The Parallel Port

You may have noticed that I've said very little about the parallel port. We intend to use it with a paper-tape reader, but we have not yet interfaced our reader. If you intend to use the board in such a capacity, I suggest you check to see if the following control lines will suffice for your reader. Control lines on the parallel port include "Input to Bus," "Output Ready," "$\overline{\text{TR}}$ Enable" and "Data Ready."

Summary

The Speakeasy I/O interface is an inexpensive general-purpose I/O board that works quite well in our system. We chose it because it seemed to be the most cost-effective way to get serial, parallel and cassette I/O for our home computer.

Again, let me say the kit is not for a beginner, but don't let me scare you off. If you've never built a kit before, get some help from a friend or your local computer hobbyist club. You'll want some guidance and perhaps something else to practice on.

We had no problems putting the kit together, and the tests included here proved the interface to be working the first time. All in all, we are very pleased with the Speakeasy interface board. ■

```
STMNT     LOC     OBJECT CODE       SOURCE STATEMENT

    1                               *
    2                               * THIS ROUTINE TESTS THE COPE SOFTWARE BY WRITING OR
    3                               * READING TO CASSETTE ONE.  BASICLY YOU SET UP AN
    4                               * AREA OF MEMORY TO A KNOWN STATE (SOME CHARACTERS)
    5                               * THEN WRITE IT.  RESET THE BUFFER POINTER THEN
    6                               * READ IT BACK IN.  THEN EXAMINE THE AREA THAT WAS
    7                               * JUST READ BACK IN TO MAKE SURE ITS THE SAME AS
    8                               * WHAT WAS WRITTEN OUT.  IF NOT TRY ADJUSTING THE
    9                               * VOLUME CONTROL ON THE CASSETTE RECORDER.
   10                               *
   11
   12   000000     061 377 001              LXI  SP,7770       ;SET UP STACK
   13   000003     076 203                  MVI  A,2030        ;WRITE CHANNEL 1 AND STOP
   14                                                          ;CHANGE TO "2020" TO READ
   15   000005     016 000                  MVI  C,0           ;STANDARD READ (NO SKIP, NO COMPARE)
   16   000007     041 100 000              LXI  H,1000        ;SET OUTPUT BUFFER ADDRESS
   17   000012     021 012 000              LXI  D,120         ;SET OUTPUT BUFFER LENGTH
   18   000015     315 000 000              CALL COPE          ;CALL ON-BOARD CASSETTE DRIVER
   19   000020     166                      HLT                ;DONE
   20   000000                     COPE:    EQU  0             ;MY ASSEMBLER DOES NOT GENERATE
   21                                                          ;ADDRESSES OVER 32K SO PATCH THIS
   22                                                          ;SYMBOL TO 005/201 SPLIT OCTAL
   23                                      END
```

Program E. Test of the cassette I/O routines.

Program F. Serial I/O examples, featuring read and write string subroutines.

```
STMNT     LOC     OBJECT CODE       SOURCE STATEMENT

    1                               ****************************************************************
    2                               *
    3                               *  THIS EXAMPLE SHOW HOW TO CALL THE SERIAL I/O ROUTINES
    4                               *  AND HOW TO SET UP READ LINE AND WRITE LINE ROUTINES
    5                               *  THAT MIGHT BE USED TO PATCH YOUR BASIC INTERPRETER OR
    6                               *  SYSTEM MONITOR.
    7                               *
    8                               ****************************************************************
    9
   10                               ****************************************************************
   11                               *
   12                               * GETC ROUTINE
   13                               *
   14                               * THIS IS A GENERAL SUBROUTINE FOR SERIAL INPUT
   15                               * TO USE; CALL GETC, THE CHARACTER WILL BE RETURNED IN REG A
   16                               * WITH NO PARITY BIT.  ALL OTHER REGISTERS ARE SAVED AND RESTORED
   17                               *
   18                               ****************************************************************
   19   000000     006 001     GETC:    MVI     B,1               ;NO AUTO ECHO OF INPUT CHARACTER
   20   000002     325                  PUSH    D                 ;SAVE D-E ON STACK
   21   000003     345                  PUSH    H                 ;SAVE H-L ON STACK
```

```
000004  315 000 000             CALL    INPUT           ;GO GET IT!
000007  172                     MOV     A,D             ;PUT CHARACTER IN REG A
000010  346 177                 ANI     1770            ;STRIP OFF PARITY BIT
000012  341                     POP     H               ;RESTORE H-L
000013  321                     POP     D               ;RESTORE D-E
000014  311                     RET                     ;GO HOME

                        ;*****************************************************************
                        ;*
                        ;* PUTC ROUTINE
                        ;*
                        ;* THIS IS A GENERAL SUBROUTINE FOR SERIAL OUTPUT
                        ;* PUT CHARACTER TO BE SENT IN REG A AND CALL PUTC
                        ;*
                        ;*****************************************************************
000015  365             PUTC:   PUSH    PSW             ;SAVE A AND STATUS
000016  305                     PUSH    B               ;SAVE B-C
000017  325                     PUSH    D               ;SAVE D-E
000020  345                     PUSH    H               ;SAVE H-L
000021  315 000 000             CALL    SROUT           ;SEND IT !
000024  341                     POP     H               ;RESTORE H-L
000025  321                     POP     D               ;RESTORE D-E
000026  301                     POP     B               ;RESTORE B-C
000027  361                     POP     PSW             ;RESTORE A AND STATUS
000030  311                     RET                     ;GO BACK TO CALLER

                        ;*****************************************************************
                        ;*
                        ;* CRLF ROUTINE
                        ;*
                        ;* SUBROUTINE TO OUTPUT A CARRAGE RETURN AND LINE FEED TO THE TERMINAL.
                        ;* REGISTER A IS USED.  CALLING SEQ: CALL CRLF.
                        ;* SUBROUTINES USED: PUTC
                        ;*
                        ;*****************************************************************
000031  076 015        CRLF:   MVI     A,150           ;CARRAGE RETURN
000033  315 015 000             CALL    PUTC
000036  076 012                 MVI     A,120           ;LINE FEED
000040  315 015 000             CALL    PUTC
000043  311                     RET

                        ;*****************************************************************
                        ;*
                        ;* RDLN ROUTINE
                        ;*
                        ;* SUBROUTINE TO INPUT A STRING.  THE STRING TERMINATOR CAN BE A CR
                        ;* OR LF.  IF CR IS USED A CR/LF IS ECHOED. IF LF, NO ECHO.  IF A
                        ;* RUB-OUT IS INPUT A BACKSPACE/BLANK/BACKSPACE IS ECHOED AND THE
                        ;* BUFFER POINTER IS DECRIMENTED.  TO CALL, PLACE THE BUFFER ADDRESS
                        ;* IN HL, (REG A IS USED AND NOT RESTORED) THEN CALL RDLN.  UPON
                        ;* RETURN TEST REGISTER A FOR TERMINATING CHARACTER; CR, LF, ^X.
                        ;* SUBROUTINES USED: GETC CRLF PUTC
                        ;*
                        ;*****************************************************************
000044  315 000 000    RDLN:   CALL    GETC            ;GET A CHARACTER
000047  376 177                 CPI     1770            ;IS IT A DELETE?
000051  312 075 000             JZ      RDLN1           ;YEP
000054  167                     MOV     M,A             ;MOVE CHAR TO MEMORY
000055  043                     INX     H               ;BUMP MEM POINTER
000056  376 030                 CPI     300             ;IS IT A CANCEL? (X^)
000060  310                     RZ                      ;YES
000061  376 012                 CPI     120             ;IS IT A LINE FEED
000063  310                     RZ                      ;YEP, GO HOME
000064  376 015                 CPI     150             ;IS IT A CARRAGE RETURN?
000066  302 112 000             JNZ     RDLN2           ;IF NOT GO ECHO WHATEVER IT IS
000071  315 031 000             CALL    CRLF            ;ITS A CR, ECHO A CR/LF
000074  311                     RET                     ;NOW GO HOME

000075  053             RDLN1:  DCX     H               ;DECRIMENT MEMORY POINTER (AND
                                                        ;HOPE ITS NOT THE FIRST THING HE
                                                        ;TYPED IN)
000076  076 010                 MVI     A,100           ;BACKSPACE
000100  315 015 000             CALL    PUTC
000103  076 040                 MVI     A,400           ;SPACE
000105  315 015 000             CALL    PUTC
000110  076 010                 MVI     A,100           ;BACKSPACE
000112  315 015 000    RDLN2:   CALL    PUTC
000115  303 044 000             JMP     RDLN

                        ;*****************************************************************
                        ;*
                        ;* WRLN ROUTINE
                        ;*
                        ;* SUBROUTINE TO OUTPUT A STRING.  IF STRING TERMINATOR IS A 'CR'
                        ;* THEN OUTPUT A CR/LF AFTER THE STRING.  IF THE STRING TERMINATOR
                        ;* IS A NULL THEN OUTPUT ONLY THE STRING.  TO CALL, LOAD H-L WITH
                        ;* BUFFER ADDRESS, PUSH A REG THEN CALL.
                        ;* SUBROUTINES USED: PUTC CRLF.
                        ;*
                        ;*****************************************************************
000120  176             WRLN:   MOV     A,M             ;PUT THE CHARACTER IN REG A
000121  376 015                 CPI     150             ;IS IT A CR?
000123  312 140 000             JZ      WRLN1           ;YES
000126  376 000                 CPI     0               ;IS IT A NULL?
000130  310                     RZ                      ;YES, RETURN
000131  315 015 000             CALL    PUTC            ;PUT IT OUT
000134  043                     INX     H               ;LOOK AT NEXT CHARACTER
000135  303 120 000             JMP     WRLN
000140  315 031 000    WRLN1:   CALL    CRLF            ;PUT OUT A CR/LF
000143  311                     RET

000000                  INPUT:  EQU     0               ;PATCH SYMBOL FOR INPUT
000000                  SROUT:  EQU     0               ;PATCH SYMBOL FOR OUTPUT
                                END
```

Author Postscript: Morrow has issued a new version of the documentation for this board. I received a copy without even asking. The graphics are much improved, and some new tests are included to allow checkout of some of the functions without having a terminal, reader or whatever hooked up.

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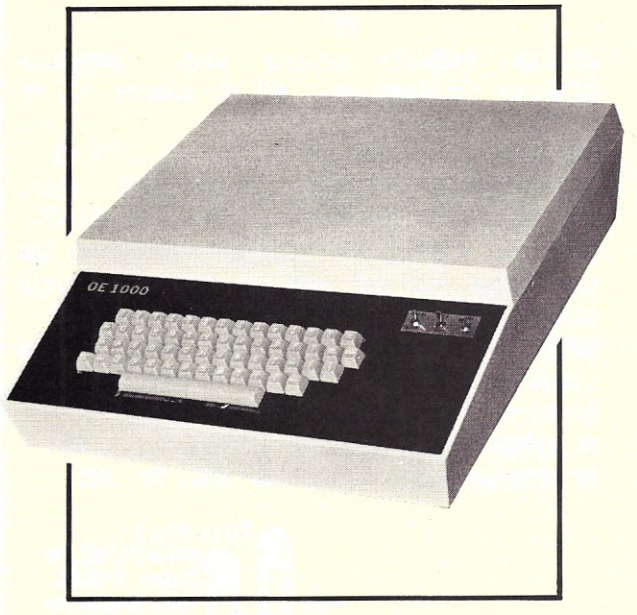
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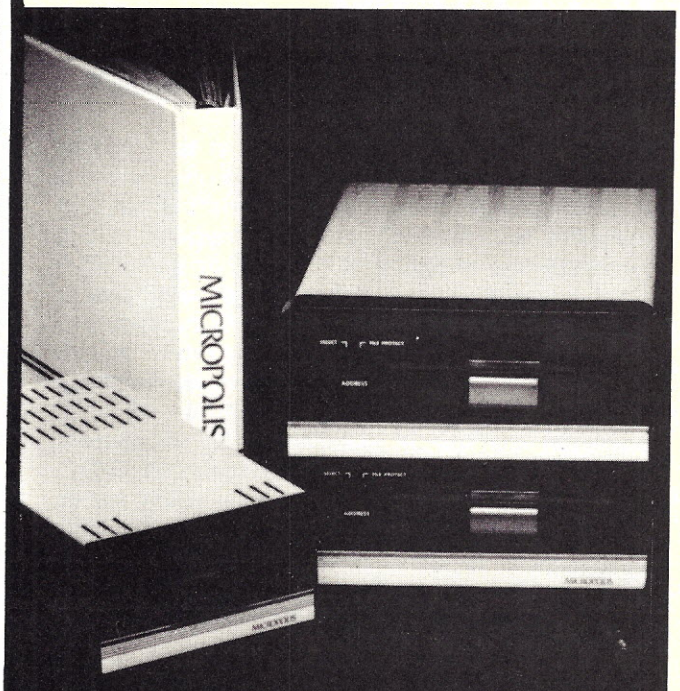
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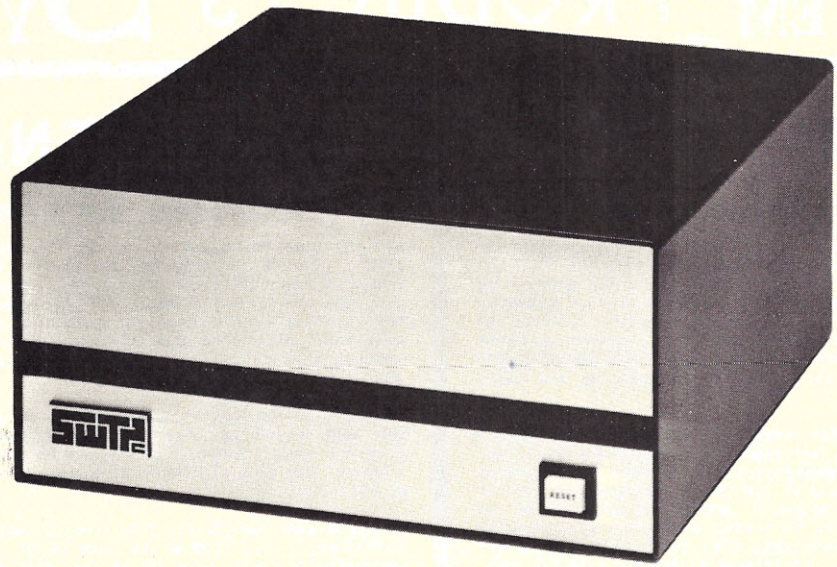
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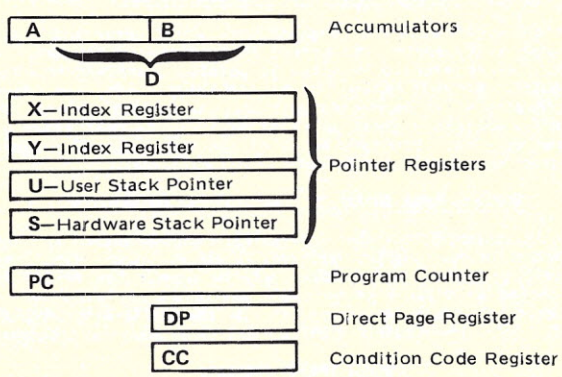


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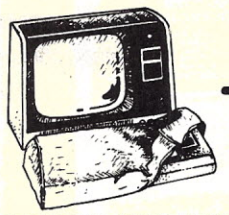
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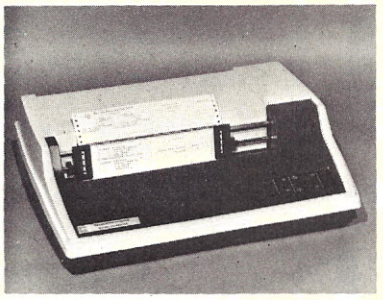
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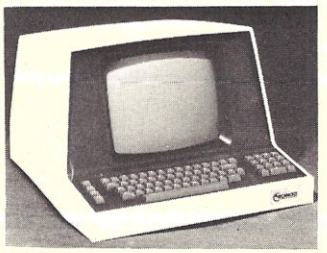
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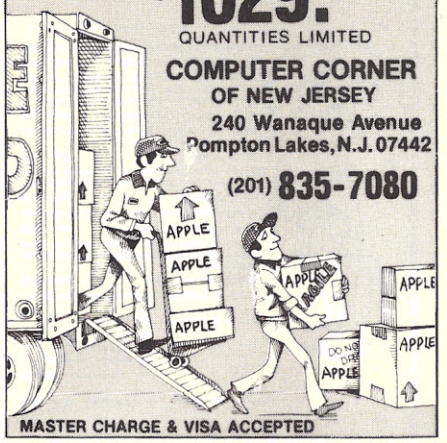
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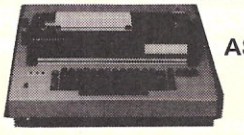
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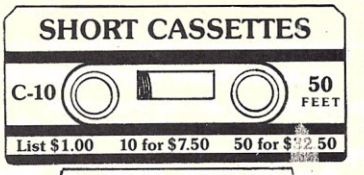
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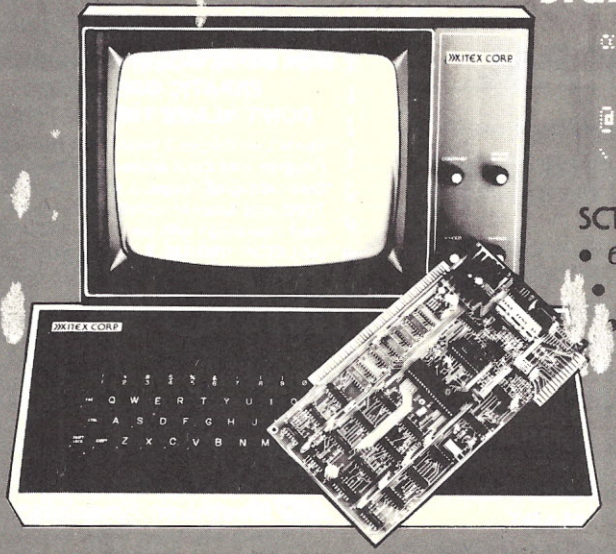
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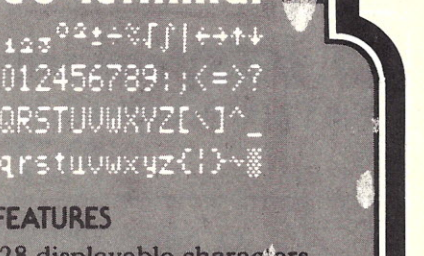
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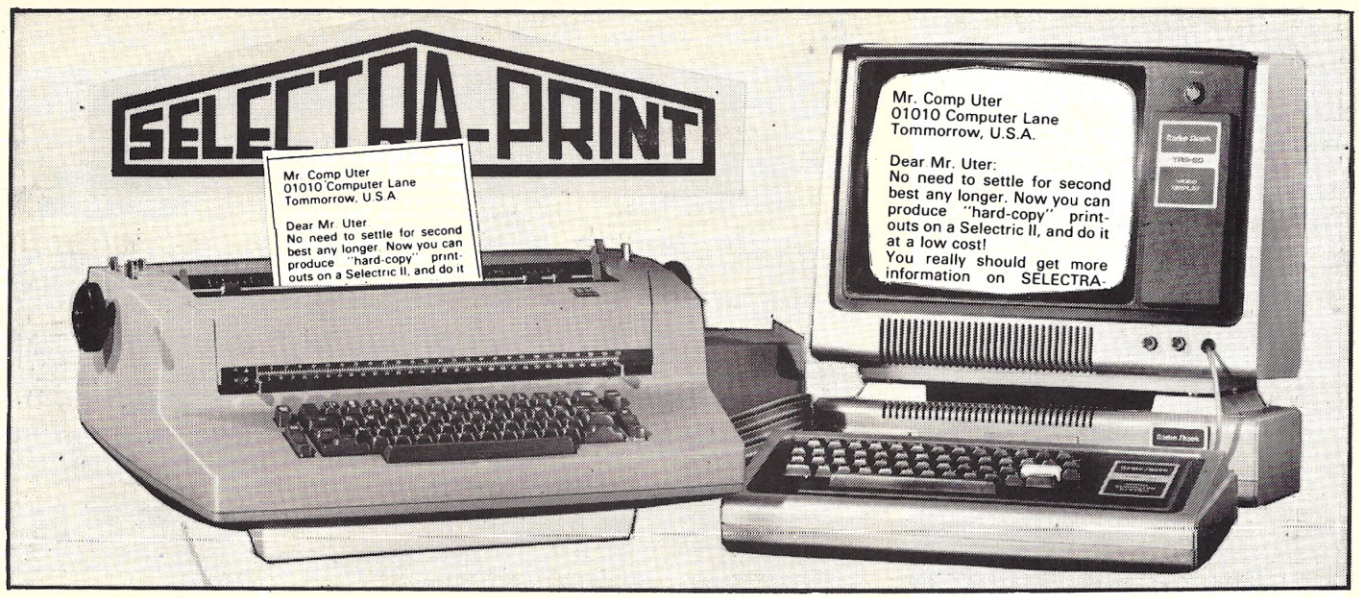
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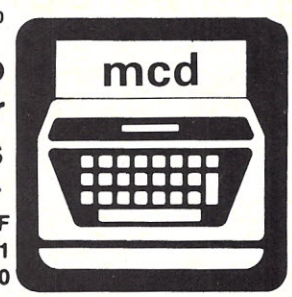
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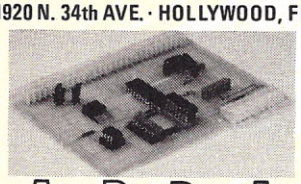
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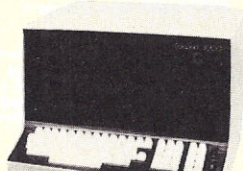
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ELF II by Netronics

Write and run programs—the very first night—even if you've never used a computer before!

You're up and running with video graphics for just $99.95 — then use low cost add-ons to create your own personal system that rivals home computers sold for 5-times ELF II's low price!

Featuring **RCA** 1802 COSMAC CPU

Own a powerful home computer system, starting for just $99.95—a price that gets you up and running the very first night...with your own TV for a video display. $99.95 ELF II includes RCA 1802 8-bit microprocessor addressable to 64k bytes with DMA, interrupt, 16 registers, ALU, 256 byte RAM, full hex keyboard, two digit hex output display, stable crystal clock for timing purposes, RCA 1861 video IC to display your programs on any video monitor or TV screen *and 5-slot plug-in expansion bus (less connectors) to expand ELF II into a giant!*

ELF II Explodes Into A Giant!

Master ELF II's $99.95 capabilities, then expand with GIANT BOARD ... KLUGE BOARD...4k RAM BOARDS...TINY BASIC...ASCII KEYBOARD... LIGHT PEN...ELF-BUG MONITOR...COLOR GRAPHICS & MUSIC SYSTEM... TEXT EDITOR...ASSEMBLER...DISASSEMBLER...VIDEO DISPLAY BOARD ...*and*—

More Breakthroughs Coming Soon!

Soon to be introduced: ELF II special application kits that give you the hardware and software you need to use ELF II for specialized purposes such as a telephone dialer...industrial controller...home photography...security system...police alert...motor controller...station output monitor on a conveyor belt assembly line...and some new, super-fantastic games!

Also coming soon: PROM Programmer...A-D, D-A Converter...Controller Board...and more! Unlike some heavily advertised hobby computers, ELF II doesn't limit you to pre-recorded programs. With ELF II you learn computing from the ground up...from machine language to assembly language to BASIC ...in quick, clear and easy steps. ELF II is a powerful computing tool, but one that you can master with the same ease you once mastered a slide rule or pocket calculator.

Master This Computer In A Flash!

Regardless of how minimal your computer background is now, you can learn to program an ELF II in almost no time at all. Our *Short Course On Microprocessor & Computer Programming*—written in non-technical language—guides you through each of the RCA COSMAC 1802's capabilities, so you'll understand *everything* ELF II can do...*and how to get ELF II to do it!* Don't worry if you've been stumped by computer books before. The *Short Course* represents a major advance in literary clarity in the computer field. You don't have to be a computer engineer in order to understand it. Keyed to ELF II, it's loaded with "hands on" illustrations. When you're finished with the *Short Course*, neither ELF II nor the RCA 1802 will hold any mysteries for you.

In fact, not only will you now be able to use a personal computer creatively, you'll also be able to read magazines such as BYTE...INTERFACE AGE...POPULAR ELECTRONICS and PERSONAL COMPUTING and fully *understand* the articles. And, you'll understand how to expand ELF II to give you the exact capabilities you need!

If you work with large computers, ELF II and the *Short Course* will help you understand what they're doing.

Get Started For Just $99.95, Complete!

$99.95 ELF II includes all the hardware and software you need to start writing and running programs at home, displaying video graphics on your TV screen and designing circuits using a microprocessor-the very first night—even if you've never used a computer before.

ELF II connects directly to the video input of your TV set, without any additional hardware, Or, with an $8.95 RF modulator (see coupon below), you can connect ELF II to your TV's antenna terminals instead.

ELF II has been designed to play all the video games you want, including a fascinating new target/missile gun game that was developed specifically for ELF II. But games are only the icing on the cake. The real value of ELF II is that it gives you a chance to write machine language programs—and machine language is the fundamental language of all computers. Of course, machine language is only a starting point. You can also program ELF II with assembly language and tiny BASIC. But ELF II's machine language capability gives you a chance to develop a working knowledge of computers that you can't get from running only pre-recorded tape cassettes.

ELF II Gives You The Power To Make Things Happen!

Expanded, ELF II can give you more power to make things happen in the real world than heavily advertised home computers that sell for a lot more money. Thanks to an ongoing committment to develop the RCA 1802 for home computer use, the ELF II products—being introduced by Netronics—keep you right on the outer fringe of today's small computer technology. It's a perfect computer for engineering, business, industrial, scientific and personal applications.

Plug in the **GIANT BOARD** to record and play back programs, edit and debug programs, communicate with remote devices and make things happen in the outside world. Add **Kluge** (prototyping) **Board** and you can use ELF II to solve special problems such as operating a complex alarm system or controlling a printing press. Add **4k RAM Boards** to write longer programs, store more information and solve more sophisticated problems.

ELF II add-ons already include the **ELF II Light Pen** and the amazing **ELF-BUG Monitor**—two extremely recent breakthroughs that have not yet been duplicated by any other manufacturer.

The ELF-BUG Monitor lets you debug programs with lightening speed because the key to debugging is to know what's inside the registers of the microprocessor. And, with the ELF-BUG Monitor, instead of single stepping through your programs, you can now display the entire contents of the registers on your TV screen. You find out immediately what's going on and can make any necessary changes.

The incredible ELF II Light Pen lets you write or draw anything you want on a TV screen with just a wave of the "magic wand." Netronics has also introduced the ELF II Color Graphics & Music System—more breakthroughs that ELF II owners were the first to enjoy!

ELF II Tiny BASIC

Ultimately, ELF II understands only machine language—the fundamental coding required by all computers. But, to simplify your relationship with ELF II, we've introduced an **ELF II Tiny BASIC** that makes communicating with ELF II a breeze.

Tiny BASIC saves you the time of having to code your individual instructions in machine language for ELF II. Instead, you simply type instructions on a keyboard —PRINT, RUN, LOAD, ETC. Your Tiny BASIC program automatically translates them into machine language for ELF II. Then it translates ELF II's output back into simple words and symbols for you.

Now Available! Text Editor, Assembler, Disassembler And A New Video Display Board!

The Text Editor gives you word processing ability and the ability to edit programs or text while it is displayed on your video monitor. Lines and characters may be quickly inserted, deleted or changed. Add a printer and ELF II can type letters for you—error free—plus print names and addresses from your mailing list!

ELF II's **Assembler** translates assembly language programs into hexidecimal machine code for ELF II use. The Assembler features mnemonic abbreviations rather than numerics so that the instructions on your programs are easier to read—this is a big help in catching errors.

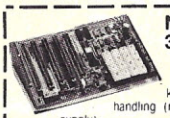
ELF II's **Disassembler** takes machine code programs and produces assembly language source listings. This helps you understand the programs you are working with...and improve them when required.

The new **ELF II Video Display Board** lets you generate a sharp, professional 32 or 64 character by 16 line upper and lower case display on your TV screen or video monitor—dramatically improving your unexpanded $99.95 ELF II. When you get into longer programs, the Video Display Board is a real blessing!

Ask Not What Your Computer Can Do... But WHAT CAN IT DO FOR YOU?

Don't be trapped into buying an expensive dinosaur, simply because you can afford it. ELF II is more advanced and more fun to use than big name computers that cost a lot more money. With ELF II you learn to write and run your own programs. You're not just a keypunch operator. No matter what your interests are, ELF II is the fastest way to get into computers.

Order from the coupon below!



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Yes! I want my own computer! Please rush me—

☐ RCA COSMAC ELF II kit at $99.95 plus $3 postage and handling (requires 6.3 to 8 volt AC power supply).

☐ Power Supply (required). $4.95 postpaid.

☐ RCA 1802 User's Manual, $5 postpaid.

☐ Tom Pittman's **Short Course On Microprocessor & Computer Programming** teaches you just about everything there is to know about ELF II or any RCA 1802 computer. Written in non-technical language, it's a learning breakthrough for engineers and laymen alike. $5 postpaid.

☐ Deluxe Metal Cabinet with plexiglas dust cover for ELF II. $29.95 plus $2.50 p&h.

☐ I am also enclosing payment (including postage & handling) for the items checked below!

☐ **I want my ELF II wired and tested with power supply, RCA 1802 User's Manual and Short Course—all for just $149.95 plus $3 p&h.**

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ALSO AVAILABLE FOR ELF II

☐ **GIANT BOARD™** kit with cassette I/O, RS 232-C/TTY I/O, 8-bit P I/O, decoders for 14 separate I/O instructions and a system monitor/editor. **$39.95** plus $2 p&h.

☐ **Kluge** (Prototype) **Board** accepts up to 36 IC's. **$17.00** plus $1 p&h.

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☐ **Professional ASCII Keyboard** kit with 128 ASCII upper/lower case set, 96 printable characters, onboard regulator, parity, logic selection and choice of 4 handshaking signals to mate with almost any computer. **$64.95** plus $2 p&h.

☐ **Deluxe metal cabinet for ASCII Keyboard. $19.95** plus $2.50 p&h.

☐ **Video Display Board** kit lets you generate a sharp, professional 32 or 64 character by 16 line upper and lower case display on your tv screen or video monitor—dramatically improving your unexpanded $99.95 ELF II. (Fits inside ASCII Keyboard cabinet.) **$89.95** plus $2 p&h.

☐ **ELF II Tiny BASIC** on cassette tape. Commands include SAVE, LOAD, ±, ×, ÷, (), 26 variables A-Z, LET, IF/THEN, INPUT, PRINT, GO TO, GO SUB, RETURN, END, REM, CLEAR, LIST, RUN, PLOT, PEEK, POKE. Comes fully documented and includes alphanumeric generator required to display alphanumeric characters directly on your tv screen without additional hardware. Also plays tick-tack-toe plus a drawing game that uses ELF II's hex keyboard as a joystick. 4k memory required. **$14.95** postpaid.

☐ Tom Pittman's **Short Course on Tiny Basic** for ELF II. **$5** postpaid.

☐ **ELF-BUG™ Deluxe System Monitor** on cassette tape. Allows displaying the contents of all registers on your tv at any point in your program. Also displays 24 bytes of memory with full addresses, blinking cursor and auto scrolling. A must for the serious programmer! **$14.95** postpaid.

☐ **Text Editor** on cassette tape gives you the ability to insert, delete or edit lines and words from your programs while they are displayed on your video monitor. (Add printer and you can use ELF II to type error-free letters plus insert names and addresses from your mailing list.) **$19.95** postpaid.

☐ **Assembler** on cassette tape translates assembly language programs into hexidecimal machine code for ELF II use. Mnemonic abbreviations for instructions (rather than numerics) make programs easier to read and help prevent errors. **$19.95** postpaid.

☐ **Disassembler** on cassette tape takes machine code programs and produces assembly language source listings to help you understand and improve your programs. **$19.95** on cassette tape.

SAVE $9.90—Text Editor, Assembler & Disassembler purchased together, only **$49.95!** (Require Video Display Board plus 4k memory.)

☐ **ELF II Light Pen,** assembled & tested, **$7.95** plus $1 p&h.

☐ **ELF II Color Graphics & Music System Board** kit, **$49.95** plus $2 p&h.

☐ ELF II connects directly to the video input of your tv set without additional hardware. To connect ELF II to your antenna terminals instead, order **RF Modulator, $8.95** postpaid.

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APPLE][Business Software

Micro Software Systems has developed a small business turnkey system designated as the Financial Management System (FMS). The password protected system is comprised of 30+ programs which form the following modules: INVENTORY, ACCOUNTS PAYABLES, ACCOUNTS RECEIVABLES, PAYROLL and GENERAL LEDGER.

The FMS was designed and programmed so that the user does not have to run any programs. The system is totally interconnected through menus. Menus allow function and process selections by entering single characters.

Speed was a major design consideration; thus, a machine language routine called Keyed Sequential Access Method (KSAM) was developed and put on a ROM card that is put into Slot 7. The access time was cut down to less than 2 seconds per record. KSAM keeps the file in ascending order without having to go through a program to sort the file. KSAM allowed us to make the FMS an on-line system, one in which updates are done immediately.

INVENTORY - Complete file maintenance plus selective reporting by field. Reorder report of critical parts. Point of Sales generates sales slips and refund slips, updates the inventory file, sets up accounts receivables record for the customer who charges--all done immediately. List prices may be over-ridden. Appropriate accounting is done. The inventory file can contain over 1100 records.

ACCOUNTS RECEIVABLES - Complete file maintenance plus selective reporting by field. Receipt of payments by customer or invoice. Monthly billing and aged invoices. Appropriate accounting is automatic. Complete customer file maintenance.

ACCOUNTS PAYABLES - Complete file maintenance plus selective reporting by field. Report of invoices currently payable by user entered date. Ability to put an invoice on hold so that it will not be paid. Checks are printed on a user defined format. Check approval process before checks and Check Register are printed. Ability to enter manual checks. Appropriate accounting is done. Cycle and Net terms can be used.

GENERAL LEDGER - Complete account file maintenance allows all accounts to be user defined. Journal entries are easily made. The General Ledger, Balance Sheet, and Income Statement are printed using user defined accounts and titles. The General Ledger has 4 levels of totals.

PAYROLL - The payroll module pays at frequencies of weekly, bi-weekly, monthly and bi-monthly. It allows pay types such as hourly, salary, commission, commission/draw and salary/commission. It covers unique situations where an employee works at different pay scales in the same period. Handles up to 100 employees. Prints W-2, user defined checks and Form 914. The list goes on and on. Quarterly and yearly totals are maintained on various fields. The payroll module is password protected at program level.

All key fields are validated for correctness as they are entered. Such data as the vendor number, customer number, account number, part number and invoice numbers are checked immediately against their own file.

The minimum hardware needed is 48K, 2 disks, a 132-column printer with either of Apple's interface cards (Parallel or Serial), and Applesoft II ROM card.

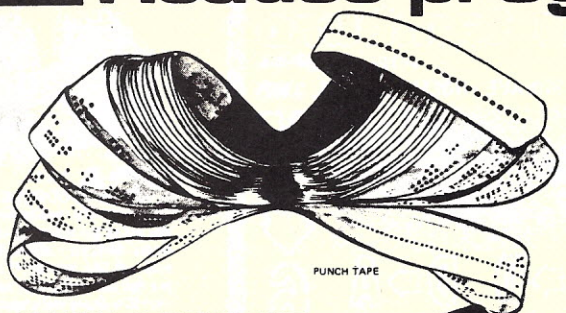
The FMS can be purchased at all fine computer stores as a package for $800.00 or by individual modules for $200.00 each. Manuals are available for $10.00 which is refundable when software is purchased.

Dealer inquiries are welcome.

Allow 3 weeks for personal checks to clear. Washington residents add 5.4% sales tax. C.O.D. orders include C.O.D. charges.

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The DATA1-K resident assembler/editor is the new, efficient approach to the assembly of microcomputer programs. All assembler editor functions are performed entirely within memory. In most cases there is no need for a special computer system! Program with the DATA1-K on the system which will ultimately make use of the object code. This not only lowers the initial cost of a development system but greatly decreases the amount of time spent on program debugging.

The DATA1-K assembles fast—over 600 lines per minute—and uses the standard MOS Technology Assembler Language. The DATA1-K features a truly general purpose line oriented text editor with error correction and paged output capability. The DATA1-K is currently in use by: General Electric, Western Electric, Eaton, Monitor Systems, the University of Cincinnati, and many others.

It is presently available on KIM-1 format paper tape or cassette and it includes one year warranty and update.

Price: $250.00

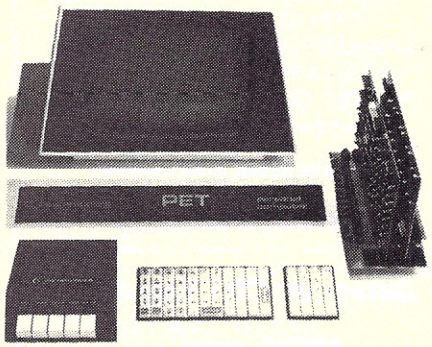
Available from Johnson Computer, P.O. Box 523, Medina, OH 44256. Phone: (216) 725-4560. Terms: Payment with order/add $2.00 shipping and handling/add $10.00 for cassette version. Delivery: stock to 30 days.

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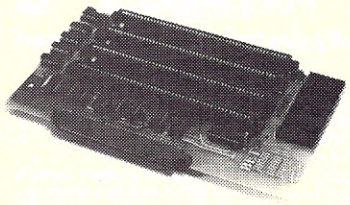
You can use the versatile new BETSI to plug the more than 150 S-100 bus expansion boards directly into your PET*!

On a single PC card, BETSI has both interface circuitry and a 4-slot S-100 motherboard. With BETSI, you can instantly use the better than 150 boards developed for the S-100 bus. For expanding your PET's memory and I/O, BETSI gives you the interface. The single board has both the complete interface circuitry required and a 4-slot S-100 motherboard, plus an 80-pin PET connector. BETSI connects to any S-100 type power supply and plugs directly into the memory expansion connector on the side of your PET's case. And that's it. You need no additional cables, interfaces or backplanes. You don't have to modify your PET in any way, and BETSI doesn't interfere with PET's IEEE or parallel ports. And—when you want to move your system—BETSI instantly detaches from your PET.

BETSI is compatible with virtually all of the S-100 boards on the market, including memory and I/O boards. BETSI has an on-board controller that allows the use of the high-density low-power "Expandoram" dynamic memory board from S.D. Sales. This means you can expand your PET to its full 32K limit on a single S-100 card! Plus, you won't reduce PET's speed when you use either dynamic or static RAM expansion with BETSI. Additionally, BETSI has four on-board sockets and decoding circuitry for up to 8K of 2716-type PROM expansion (to make use of future PET software available on PROM). BETSI jumpers will address the PROMs anywhere within your PET's ROM area, too.



BETSI is the new Interface/Motherboard from Forethought Products—the makers of KIMSI™—which allows users of Commodore's PET Personal Computer to instantly work with the scores of memory and I/O boards developed for the S-100 (Imsai/Altair type) bus. BETSI is available from stock on a single 5½" x 10" printed circuit card.



BETSI is available off-the-shelf from your local dealer or (if they're out) directly from the manufacturer.

MAIL ORDERS ARE NORMALLY SHIPPED WITHIN 48 HOURS. VISA AND MASTER-CHARGE ORDERS ARE BOTH ACCEPTED.

The BETSI Interface/Motherboard Kit includes all components, a 100-pin connector, and complete assembly and operating instructions for $119.

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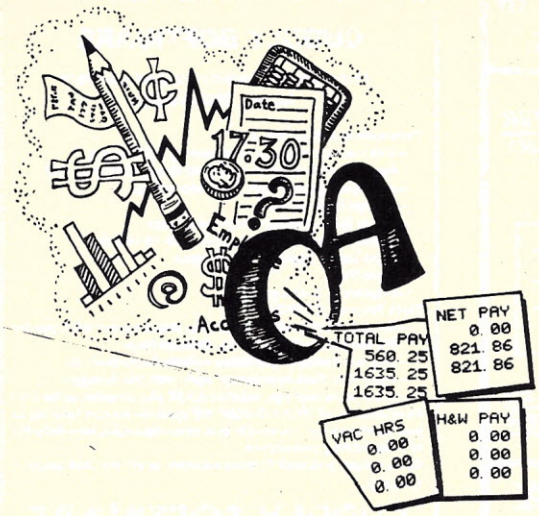
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✓ Reader Service—see page 179



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Osborne & Associates is publishing its business systems in book form. These systems represent five years of development and testing by O&A programmers, and the books include more than a year's worth of extensive and detailed documentation.

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And if Wang BASIC won't work, or you don't know programming, or you'd rather not key in thousands of words of source code, take a look at the list of consultants who have adopted O&A programs, converted them to run on many popular systems, and are waiting to hear from you.

CP/M CBASIC: GOOD NEWS FOR CONSULTANTS, COMPUTER STORES AND SOFTWARE HOUSES

Osborne & Associates is converting its business software from Wang BASIC — as it was originally published — to CP/M CBASIC, which runs on many floppy disk-based microcomputer systems. We will only sell the CP/M magnetic surface to consultants, computer stores and software houses. Osborne & Associates prefers to write and sell books, not customize the programs or answer the end user's questions. The disk for each book sells for $250.00. Once you buy the floppy disk you can copy it, resell it, change it or use it. We place no restriction on the magnetic surface; we copyright only the printed word in our books. CBASIC Payroll is available now. All three systems are scheduled to be available in the first half of 1979; call or write for the exact availability of each system.

If you are an end user interested in the CBASIC programs, write or call us. We will put you in touch with your closest dealer.

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13-6 Accounts Payable/Receivable	$15.00		
20-9 General Ledger	$15.00		

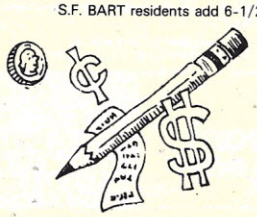
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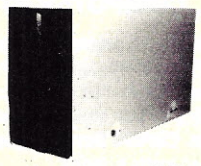
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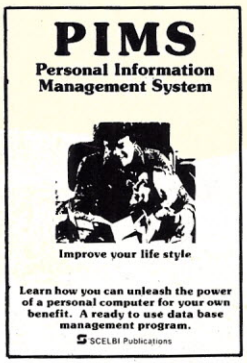
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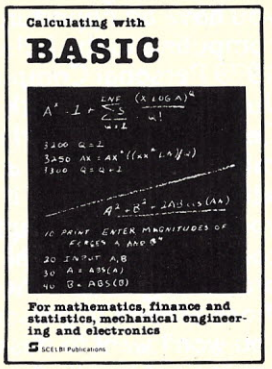


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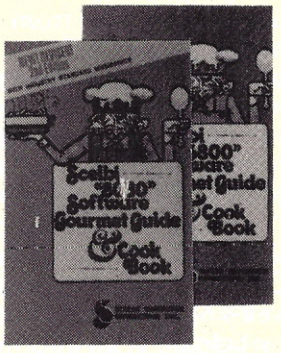
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CORRECTIONS

Both author David Koh and reader Larry Preston of Grand Blanc MI have written to correct a schematic error in Koh's article, "Raster Scan Graphics for the 6800," in the November 1978 issue. In Fig. 3 on page 29, GIC 17d pins 11 and 13 should be reversed. The original and corrected numberings are shown in Fig. 1.

Wally Izuo of Honolulu HI points out that we printed a negative backward and showed the component side, not the copper side, in "Copying Computer Cassettes," Fig. 3 (August 1978, p. 95). The corrected artwork is shown in Fig. 2.

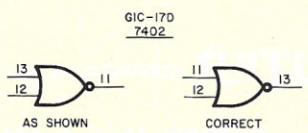


Fig. 1.

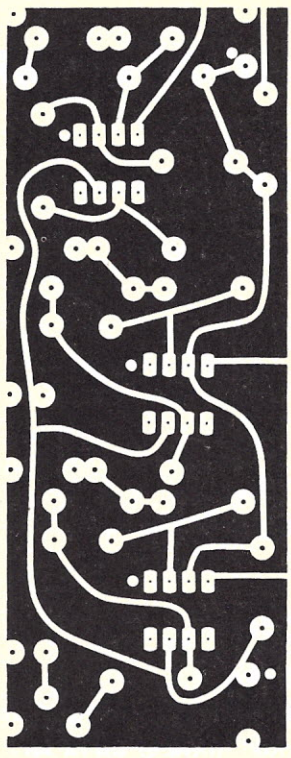


Fig. 2.

Contest!

They're here—the results of the latest contest drawings.

Voted "best article of the month" in the February 1979 issue was "It's There—But Where?" by. S. J. Mathis, Jr.

Winner of a book from the Book Nook is Wayne W. Bayles, Jr., of Annandale VA.

The winner of a lifetime subscription to *Kilobaud MICROCOMPUTING* can be found on page 4.

Our congratulations to one and all.

KB CALENDAR

San Francisco CA

The fourth annual West Coast Computer Faire will be held in San Francisco's Civic Auditorium during May 11-13, 1979.

The Faire is primarily concerned with inexpensive computing for home, business and industry. Conferences covering topics in these areas are scheduled.

Arlington VA

A symposium on "Microcomputers in Education and Training" will be held in Arlington VA, May 17-18, 1979. For information, write to the Society for Applied Learning Technology, 50 Culpeper Street, Warrenton VA 22186, or call (703) 347-0055.

Pasadena CA

Infotech International, Inc., is presenting spring/summer state-of-the-art conferences and tutorials, which will be held April, May and June in Washington DC, San Francisco and Chicago, respectively.

For more information, write to Infotech International, Inc., 234 E. Colorado Boulevard, Pasadena CA 91101, or call (213) 793-0687.

Paris, France

Micro/Expo '79 is scheduled at the Palais des Congres in Paris on May 15-17. Billed as the largest show in Europe, the fourth annual microcomputer show is organized by Sybex-Europe. Contact Chris Chambers, Sybex, Inc., 2020 Milvia St., Berkeley CA 94704, or call (415) 848-8233.

Clemson SC

The Clemson Conference on Small Computers: Applications for Business, Industry, Education, Medicine will be held at Clemson University, Clemson SC, on May 23 and 24. Discussions on a variety of applications, tutorials on small systems and exhibits of equipment will be featured. For more information, contact Continuing Engineering Education, Clemson University, Clemson SC 29631.

Chicago IL

The Design and Selection of Minicomputer Systems, sponsored by the American Management Associations, will be held May 7-9 at the AMA Management Center in Chicago. Future sessions are planned for New York on June 11-13 and in Boston from July 16-18. For registration information, contact the AMA, 135 W. 50th St., New York NY 10020, or call (212) 246-0800.

Chicago IL

Papers are being solicited for the Third International Conference on Computer Software and Applications, COMPSAC '79, sponsored by the IEEE Computer Society, in Chicago. Deadline is June 1. For additional information, contact Dr. William Smith, Executive Director, Toll Electronics Switching and Operator Services Division, Bell Laboratories, Naperville IL 60540, or call (312) 690-2389.

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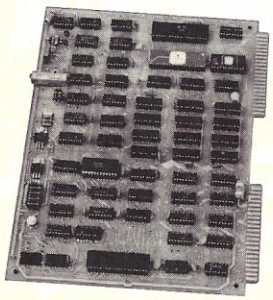


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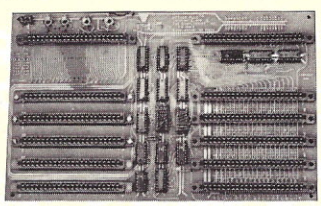
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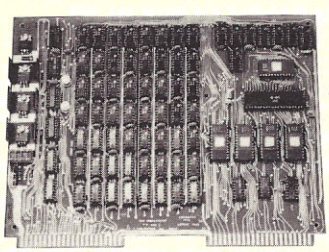
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Funny thing is that the only way I found out about them was by reading Buss. That's the newsletter on Heath Co. computers Charlie Floto puts out. When I first saw his ads I thought the guy was just another flake. But the "Heathkit™ Forum" he used to do for Wayne Green's magazine was pretty good so I figured, "Why not?" Turns out Charlie edits another newsletter on computers that goes for 87 bucks a year so I got off easy. The guy really knows what he's doing.

Anyway, the best thing about Buss as far as I'm concerned isn't the news Charlie digs up. It's those letters from other Heathkit™ users. I find out things they learned the hard way and even pick up a few hardware modifications.

Somehow Buss seems a little more personal than HUG. HUG gives me the official word from Benton Harbor, but the independent viewpoint of Buss is nice to have, too. Especially when I want to know what other companies are making for my system.

But don't take my word for it. Send in your Buss subscription and let Charlie know whether you'd rather start with the latest issue or available back issues (there were about eight last time I checked). Any time you're not satisfied with Buss, for any reason, a full refund is yours for the asking. Charlie doesn't take phone orders for subscriptions, but if you'd like to give him a call to chat you can sometimes catch him at 202/544-0484. Myself, I recommend just sending the guy your check and seeing what he comes up with. I never got a Buss I didn't like.

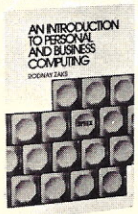
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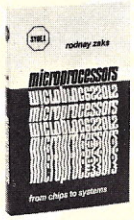
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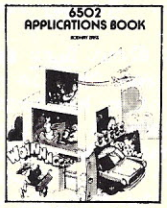
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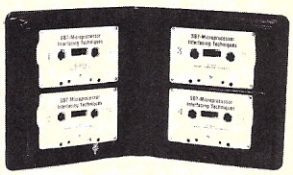
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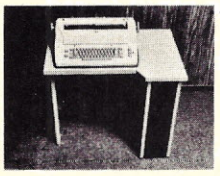
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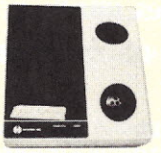
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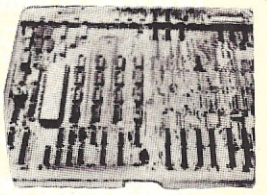
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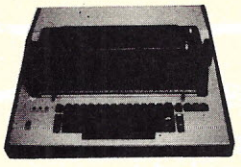
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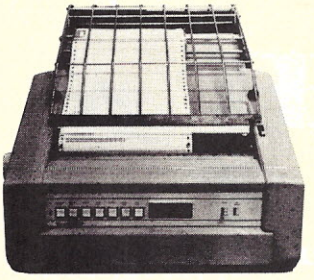
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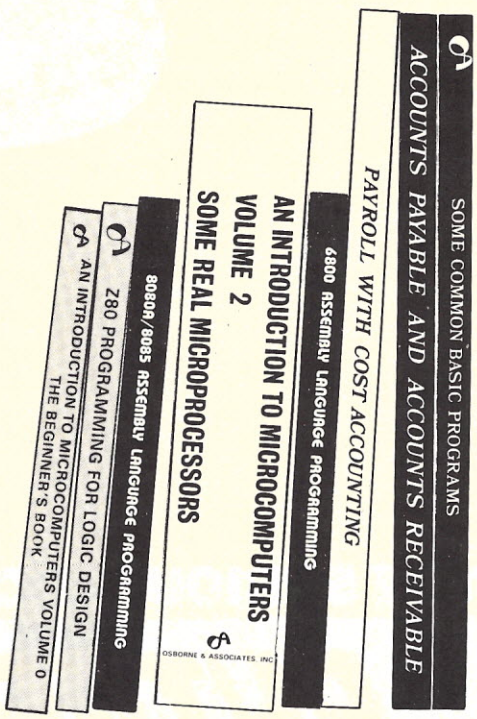
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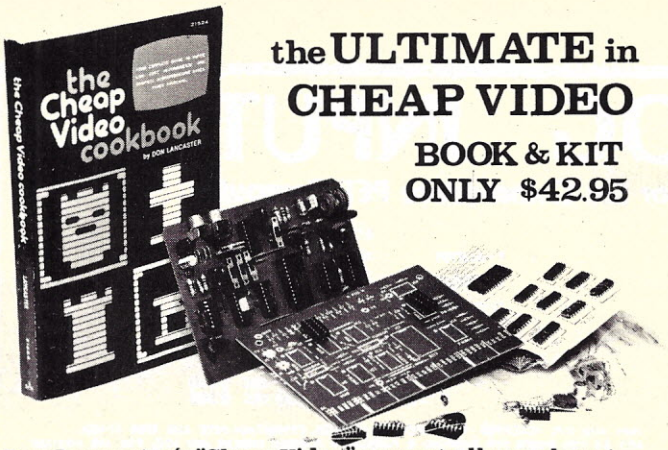
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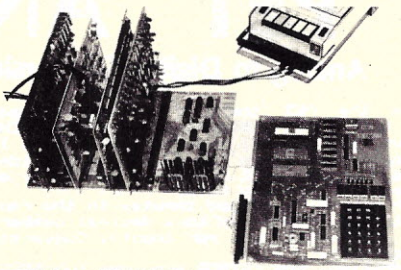
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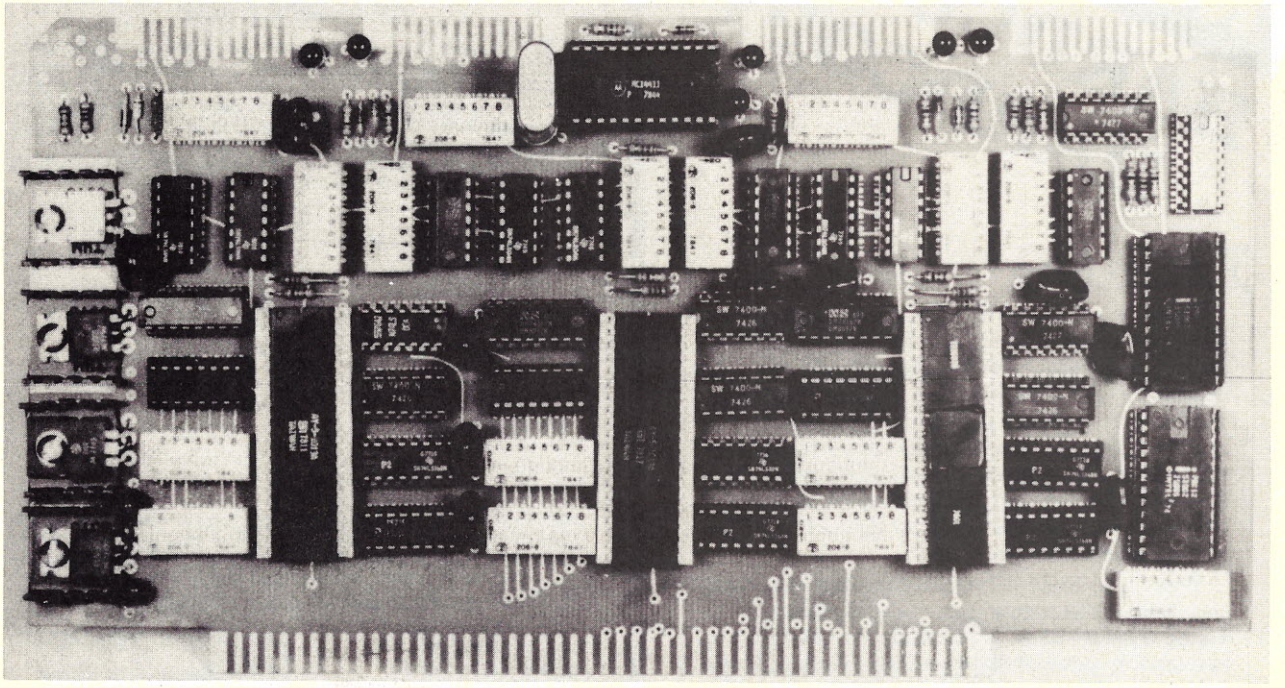
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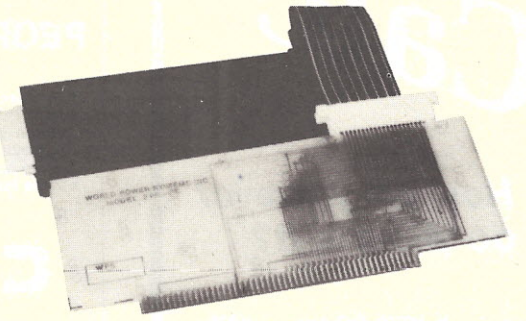
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3 POWERFUL INTERFACES
FOR THE TRS-80* AND S-100 BUS

TRS-80 TO S-100 BUS CABLE ADAPTER

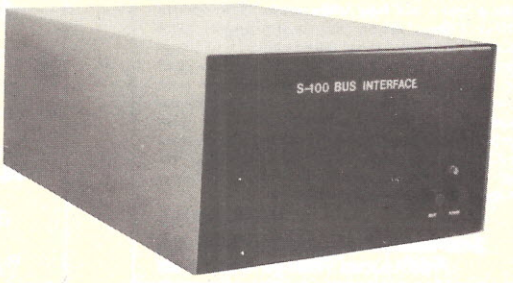
- **FULL INTERFACE:** Contained within the cable assembly, is a small enclosure. This enclosure contains all the logic to convert your TRS-80 to be compatible with the S-100 bus system.
- **FULL BUFFERING:** All address, data and signal lines are fully buffered.
- **EASY CONNECTION:** It is easy to connect. Just plug the one end of the cable into one slot on your S-100 system and plug the other end into the rear of the TRS-80 keyboard or between the expansion interface. Turn on and go . . .
- **TWO EDGE CONNECTORS:** Two addition 40 pin port edge connectors are provided for other connection of expansion interfaces.
- **POWER:** All power is derived from the S-100 bus structure. Since the TRS-80 will not support other devices hooked to its power supply, it is a must that your S-100 supply 8-10 volts D.C. Logic card contained within the cable has on board 5 volt regulator. Current requirements is 375 ma. Unit has separate terminal for exterior connection of DC power requirement if it is to be supplied outside the S-100 bus system.
- **FULL OPERATION MANUAL:** Not much need for a manual, but we have prepared one with full principal of operation, etc.



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TRS-80 TO S-100 BUS

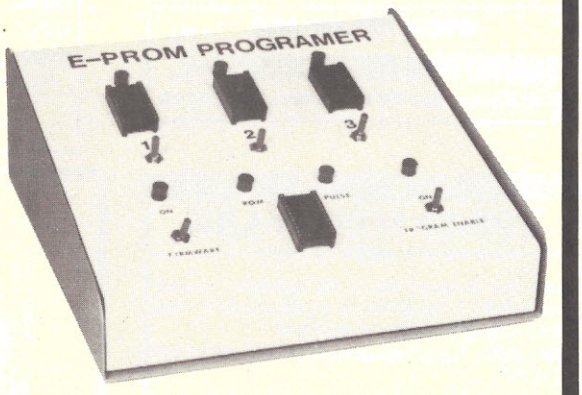
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- **BUS TERMINATION:** Bus termination and conditioning for no croos talk or noise etc.
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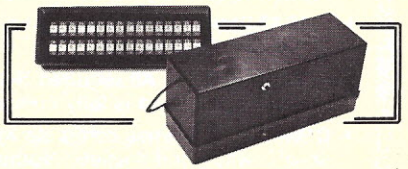
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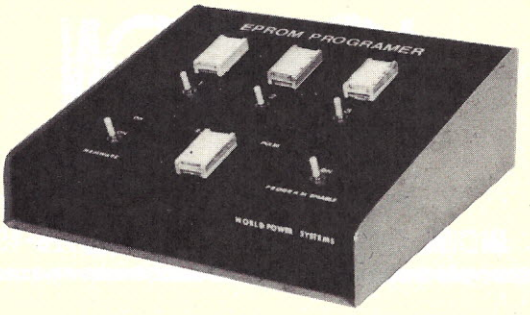
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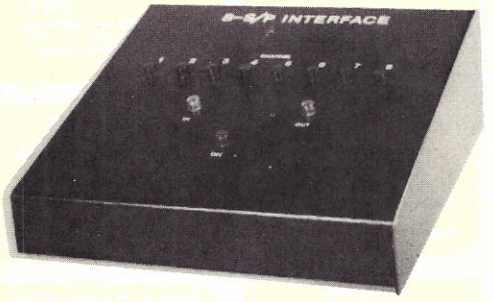


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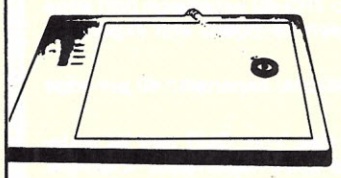
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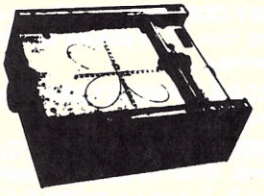


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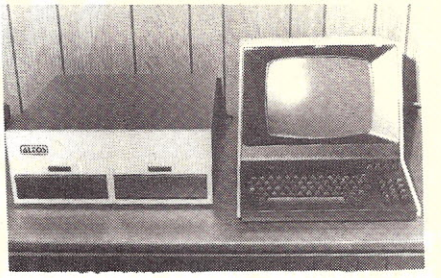
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Auburn, Alabama 36830 ✓P43
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Unless otherwise stated, all items assembled, tested, warrantied 90 days for parts and labor

Sales & Service for OSI, Altos, Commodore, Compucolor & HDE

ALTOS ACS-8000 SUN SERIES: a new standard in CP/M based systems

-Single board construction for highest bandwidth, signal purity, reliability, ease of maintenance, and lowest cost.
-4 mhz. Z80 w/32K 200 nanosecond 4116 RAM, sockets for 64K
-Dual Shugart 8" drives-single density/sided standard; double density and/or double sided drives optional.
-28 megabyte hard disk (Shugart) available this summer in matching cabinet.
-Large prototyping board available for custom applications; installs next to main board. (room for 75 16 pin IC's)
-2 accessory AC outlets for printer, terminal, etc.
-2 RS-232 and one 16 bit parallel port standard.
-PASCAL, COBOL, CBASIC, FORTRAN, and Z80 macro assembler
-90 day warranty for parts/labor.

When high bandwidth (high speed), low cost, and reasonable expandability are considered, the price/performance advantages of a single board design far outweigh the advantages of a so called 'standard' bus configuration. Why pay thousands more for lower performance? Altos decided that hardware requirements were adequately met with a single "6x9" board!

ACS-8000-1, 32K, single density/sided (500Kbyte) $3840.00
ACS-8000-2, 32K, double density/sing. sided (1 mbyte) $4500.00
ACS-8000-3, 32K, single density/doub. sided (1mbyte) $4800.00
ACS-8000-4, 32 K, double density/doub. sided (2 mbyte) $5300.00
additional 16K ram-$99: proto board w/connector $150.00
CP/M free with computer: CBASIC $100.00: Fortran IV $500.00: PASCAL $200.00: COBOL $770.00: Z80 macro assembler $100.00

ALL ITEMS AVAILABLE NOW!

SAVE BY BUYING COMPLETE SYSTEMS!

ALTOS SYSTEM (1):
ACS-8000-1, 32 K, W/CP/M, Altos utilities- $3840
CBASIC $100
Hazeltine 1500 with full end-user warranty! (90 day parts, labor, usually ON-SITE, from Hazeltine! $1195
TEXAS INSTRUMENTS 810 printer, with RS-232- (with full factory warranty!) Comparable to Centronics 703) $1895
Printer Cable $35
ALTOS SYSTEM (1), list price $7065
SPECIAL SYSTEM PRICE ~~$6095~~

Beware of the poor warranties most 'bargain basement' peripherals include! ALL peripherals (unless otherwise stated) from Plainsman Micro Systems include the FULL (usually on-site) WARRANTY and service from the manufacturer.

VISIT OUR RETAIL STORES!

The Logic Store
Columbus Square Mall
3050 Macon Road
Columbus, Georgia
(404)568-0197
R.N. Clemmons, Mgr.

The Logic Store
3808 Pepperell Parkway
Opelika, Alabama
(205)745-7735
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EVERYTHING FOR THE S-100 BUSS

* **FPB-1** FRONT PANEL BOARD
  Hex Displays, IMSAI Replaceable $54.95
* **FDC-1** FLOPPY DISC CONTROLLER BOARD
  Controls up to 8 Discs $45.00
* **MEM-1A** 8K BYTE 2102 RAM Board $31.95
* **MEM-2** 16K BYTE 2114 RAM Board $31.95
* **CPU-1** 8080A CPU Board
  With Vector Interrupt $31.95
* **EPM-1** 4K BYTE 1702A EPROM $29.95
* **EPM-2** 16K or 32K BYTE EPROM
  2708 or 2176 interchangeable $30.00
* **QMB-9** 9 SLOT MOTHER BOARD
  Terminated $35.00
* **QMB-12** 12 SLOT MOTHER BOARD
  Terminated $40.00
* **RTC** REALTIME CLOCK
  Programmable Interrupts $27.95

FUTURE PRODUCTS: 80 CHARACTER VIDEO BOARD,
IO BOARD WITH CASSETTE INTERFACE.

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wmc inc. ✓W22 WAMECO INC. 111 GLENN WAY #8, BELMONT, CA 94002 (415) 592-6141

SSM

FORMERLY CYBERCOM/SOLID STATE MUSIC.

CB-1 8080 Processor Board. 2K of PROM 256 BYTE RAM power on/rest Vector Jump Parallel port with status. Kit.....$125.95 PCBD.....$28.95

MB-6A Basic 8KX8 ram uses 2102 type rams, S-100 buss. Kit 450 NSEC .....$123.95. PCBD.....$24.95

MB-7 16KX8, Static RAM uses μP410 Protection, fully buffered KIT.....$299.95

MB-8A 2708 EROM Board, S-100, 8K8X or 16KX8 kit without PROMS $75.00 ..... PCBD $28.95

MB-9 4KX8 RAM/PROM Board uses 2112 RAMS or 82S129 PROM kit without RAMS or PROMS $72.00

IO-4 Two serial I/O ports with full handshaking 20/60 ma current loop: Two parallel I/O ports. Kit .....$130.00 PCBD $26.95

VB-1B 64 x 16 video board, upper lower case Greek, composite and parallel video with software, S-100. Kit.....$125.00 PCBD.....$26.95

Altair Compatible Mother Board, 11 x 11½ x ⅛". Board only .....$39.95. With 15 connectors.....$94.95

Extended Board full size. Board only ..... $ 9.49
With connector $13.45

SP-1 Synthesizer Board S-100
PCBD.....$42.95 KIT.....$135.95

82S23	$1.50	PRIME SUPPORT	
82S123	1.50	8080A	$ 9.95
82S126	1.95	8212	3.25
82S129	1.95	8214	6.50
82S130	3.95	8224	3.49
82S131	3.95	2114 (450 NS) Low PWR	7.25
MMI6330	1.50	2114 (250 NS) Low PWR	7.99
IM5600	1.50	2102A-2L	1.60
IM5603	1.95	2102A-4L	1.25
IM5604	3.95	2708 450 NSEC	8.95
IM5610	1.50	1702A-6	3.50
IM5623	1.95	4116 (Apple RAM)	12.95
IM5624	3.95		8/89.95

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wmc inc. WAMECO INC.

FDC-1 FLOPPY CONTROLLER BOARD will drive shugart, pertek, remic 5" & 8" drives up to 8 drives, on board PROM with power boot up, will operate with CPM (not inclulded).
PCBD $42.95

FPB-1 Front Panel. IMSAI size, hex displays. Byte. or instruction single step.
PCBD $47.50

MEM-1 8KX8 fully buffered, S-100, uses 2102 type rams PCBD $25.95

QM-12 MOTHER BOARD, 13 slot, terminated, S-100 board only $34.95

CPU-1 8080A Processor board S-100 with 8 level vector interrupt PCBD $26.95

RTC-1 Realtime clock board. Two independent interrupts. Software programmable. PCBD $25.95

EPM-1 1702A 4K Eprom card PCBD $25.95

EPM-2 2708/2716 16K/32K EPROM CARD PCBD $25.95

QM-9 MOTHER BOARD. Short Version of QM-12. 9 Slots PCBD $30.95

MEM-2 16K x 8 Fully Buffered 2114 Board PCBD $26.95

16K RAM BOARD by CCS fully buffered, bank select standard to IEE buss gold fingers, solder mask, plated thru holes, silk screened ..... PCBD $26.95

KLUDGE BOARD by CCS for S-100 glass epoxy over 2600 plated through holes, 4 regulators with CAPS all S-100 functions labeled, gold fingers. PCBD $29.95

MIKOS

(415) 592-1800 ✓M39

419 Portofino Drive San Carlos, California 94070

Please send for IC, Xistor and Computer parts list.

MAY SPECIAL SALE ON PREPAID ORDERS
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WAMECO REAL TIME CLOCK BOARD. Kit with all factory marked parts $54.95
PCBD $23.95

FPB-1 with Mikos #14 Front Panel Kit $124.95

MIKOS PARTS ASSORTMENT WITH WAMECO AND CYBERCOM PCBDS

MEM-2 with MIKOS #7 16K ram with L2114 450 NSEC $235.95
MEM-2 with MIKOS #13 16K ram with L2114 250 NSEC $269.95
MEM-1 with MIKOS #1 450 NSEC 8K RAM $123.95
CPU-1 with MIKOS #2 8080A CPU 89.95
MEM-1 with MIKOS #3 250 NSEC 8K RAM 144.95
QM-12 with MIKOS #4 13 slot mother board 89.95
RTC-1 with MIKOS #5 real time clock 60.95
VB-1B with MIKOS #6 video board less molex connectors 99.95
EMP-1 with MIKOS #10 4K 1702 less EPROMS 49.95
EPM-2 with MIKOS #11 16-32K EPROMS less EPROMS 59.95
QM-9 with MIKOS #12 9 slot mother board 75.00

MIKOS PARTS ASSORTMENTS ARE ALL FACTORY PRIME PARTS. KITS INCLUDE ALL PARTS LISTED AS REQUIRED FOR THE COMPLETE KIT LESS PARTS LISTED. ALL SOCKETS INCLUDED.

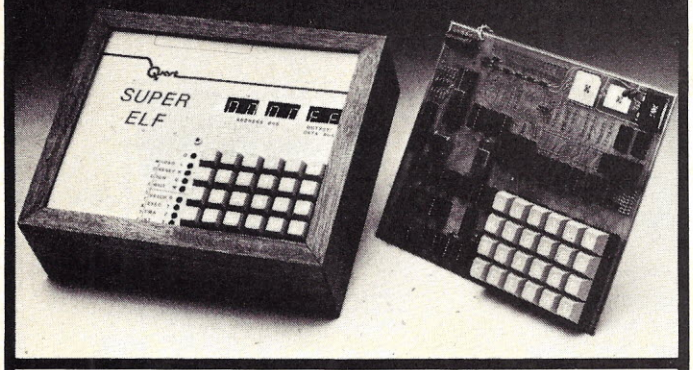
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RCA Cosmac Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded** with **additional memory, Tiny Basic, ASCII Keyboards, video character generation, etc.**

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during** and **after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on nine LED indicator lamps.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step**. Large, on board displays provide output and optional **high and low address**. There is a 44 pin standard connector for PC cards and a 50 pin connector for the **Quest Super Expansion Board**. Power supply and sockets for **all** IC's are included in the price plus a detailed 90 page instruction manual.

Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and research and development.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95. NiCad Battery Memory Saver Kit $6.95.** All kits and options also come completely assembled and tested. **Questdata**, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year.

Tiny Basic for ANY 1802 System

Cassette $10.00. On ROM $38.00. Super Elf owners, 30% off. **Object code listing with manual $5.00. Object list, manual and paper tape $10.00. Original ELF Kit Board $14.95.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed.** EPROM can be used for the monitor and Tiny Basic or other purposes.

A IK Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up.

Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. A Godbout 8K RAM board is available for $135.00. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $12.50 for easy connection between the **Super Elf** and the **Super Expansion Board.**

The **Power Supply Kit** for the Super Expansion Board is a 5 amp supply with multiple positive and negative voltages $29.95. Add $4.00 for shipping. Prepunched frame $5.00. Case $10.00. Add $1.50 for shipping.

INTEGRATED CIRCUITS

7400TTL

7400N	.17
7402N	.17
7404N	.19
7409N	.23
7410N	.17
7414N	.63
7420N	.17
7422N	1.39
7430N	.20
7442N	.50
7445N	.69
7447N	.60
7448N	.69
7450N	.17
7474N	.29
7475N	.49
7485N	.88
7489N	2.00
7490N	.43
7492N	.43
7493N	.43
7495N	.69
74100N	.90
74107N	.29
74121N	.34
74123N	.59
74125N	.39
74145N	.69
74150N	.95
74151N	.69
74154N	1.00
74157N	.59
74161N	.87
74162N	.87
74163N	.87
74174N	.96
74175N	.90
74190N	1.15
74192N	.87
74193N	.85
74221N	1.55
74298N	1.65
74365N	.66
74366N	.66
74367N	.66

74LS00 TTL

74LS00N	.25
74LS02N	.25
74LS04N	.25
74LS05N	.25
74LS08N	.25
74LS10N	.25
74LS13N	.40
74LS14N	.90
74LS20N	.25
74LS22N	.25
74LS28N	.41
74LS30N	.25
74LS33N	.39
74LS38N	.30
74LS74N	.35
74LS75N	.47
74LS90N	.51
74LS93N	.51
74LS95N	1.89
74LS107N	.35
74LS112N	.35
74LS113N	.35
74LS132N	.72
74LS136N	.35
74LS151N	.67
74LS155N	.67
74LS157N	.67
74LS162N	.91
74LS163N	.91
74LS174N	.95
74LS190N	1.06
74LS221N	1.95
74LS258N	.67
74LS367N	.89

LINEAR

CA3045	.90
CA3046	.67
CA3081	1.80
CA3082	1.90
CA3089	2.95
LM301AN/AH	.35
LM305H	.87
LM307N	.35
LM308N	.89
LM309H	1.15
LM309K	.95
LM311H/N	.90
LM317T/K	2.92
LM318	1.35
LM320K-5	1.20
LM323K-5	6.95
LM320K-12	1.35
LM320K-15	1.35
LM320T-5	1.60
LM320T-8	1.60
LM320T-12	1.50
LM320T-15	1.60
LM324N	1.15
LM339N	1.55
LM340K-5	1.35
LM340K-8	1.35
LM340K-12	1.35
LM340K-15	1.35
LM340K-24	1.35
LM340T-5	1.25
LM340T-8	1.25
LM340T-12	1.25
LM340T-15	1.25
LM340T-18	1.25
LM340T-24	1.25
LM343H	4.50
LM350	7.50

LM370	1.15
LM377	3.00
LM379	5.00
LM380N	1.00
LM381	1.60
LM382	1.60
LM703H	.40
LM709H	.28
LM723H/N	.50
LM733N	.67
LM741CH	.35
LM741N	.25
LM747H/N	.62
LM748N	.35
LM1303N	.82
LM1304	1.10
LM1305	1.27
LM1307	2.00
LM1310	2.75
LM1458	.47
LM1800	1.75
LM1812	7.50
LM1889	3.00
LM2111	1.75
LM2902	1.50
LM3900N	.60
LM3905	1.75
LM3999N	.61
MC1458V	.52
NE540L	2.89
NE550N	.65
NE555V	.43
NE556A	.79
NE565A	1.00
NE566V	1.50
NE567V	1.20
NE570B	5.00
NE571B	5.00
78L05	.60
78L08	.60
79L05	.70
78M05	.85
75108	1.75
75491CN	.50
75492CN	.55
75494CN	.89

A to D CONVERTER

8038B	4.50
8700CJ	13.95
8701CN	22.00
8750CJ	13.95
LD130	9.95
9400CJV/F	7.40
ICL7103	9.50
ICL7107	14.25

CMOS

CD34001 Fair.	.50
CD4000	.16
CD4001	.21
CD4002	.21
CD4006	1.10
CD4007	.21
CD4008	.21
CD4009	.39
CD4010	.39
CD4011	.21
CD4012	.21
CD4013	.36
CD4014	.86
CD4015	.86
CD4016	.36
CD4017	.94
CD4018	.94
CD4019	.21
CD4020	1.02
CD4021	1.02
CD4022	.86
CD4023	.21
CD4024	.75
CD4025	.21
CD4026	1.51
CD4027	.36
CD4028	.79
CD4029	1.02
CD4030	.21
CD4035	1.02
CD4040	1.02
CD4042	.71
CD4043	.63
CD4044	.63
CD4046	1.67
CD4049	.36
CD4050	.36
CD4051	1.13
CD4060	1.42
CD4066	.71
CD4068	.40
CD4069	.40
CD4070	.40
CD4071	.21
CD4072	.21
CD4073	.21
CD4075	.21
CD4076	1.75
CD4078	.40
CD4081	.21
CD4082	.21
CD4116	.47
CD4490	5.50
CD4507	1.00
CD4508	4.25
CD4510	1.02
CD4511	.94
CD4515	2.52
CD4516	1.10
CD4518	1.02
CD4520	1.02
CD4527	1.51
CD4528	.79

CD4553	3.50
CD4566	2.25
CD4583	4.50
CD4585	1.10
CD40192	3.00
74C00	.28
74C04	.33
74C10	.28
74C14	2.10
74C20	.28
74C30	.28
74C48	1.95
74C74	.75
74C76	1.40
74C90	1.15
74C93	1.40
74C154	3.00
74C160	1.44
74C175	1.35
74C192	1.65
74C221	2.00
74C905	3.00
74C906	.75
74C914	1.95
74C922	5.50
74C923	5.50
74C925	6.95
74C926	6.95
74C927	6.95

INTERFACE

8095	.65
8096	.65
8097	.65
8098	.65
8T09	1.25
8T10	4.50
8T13	3.00
8T20	5.50
8T23	3.10
8T24	3.50
8T25	3.20
8T26	1.69
8T28	2.75
8T97	1.69
8T98	1.69

MOS/MEMORY RAM

2101-1	3.95
2102-1	.95
2102AL-4	1.60
21F02	1.25
2104A-4	4.95
2107B	4.95
2111-1	3.75
2112-2	3.95
2114	8.50
4116	12.95
2513B	6.30
21L02-1	1.29
MM5262	.40
MM5280	3.00
MM5320	9.95
MM5330	5.94
PD411D-3	4.00
PD411D-4	5.00
PS101L	13.95
4200A	9.95
82S25	2.90
91L02A	1.50
HD0165-5	6.95
MM57100	4.50
GIAY38500-1	9.95
MCM6571A	9.95
9368	3.50
410D	10.00
416	16.00

CLOCKS

MM5309	3.00
MM5311	3.60
MM5312	4.80
MM5313	3.60
MM5314	3.90
MM5315	4.00
MM5316	5.00
MM5318	3.60
MM5369	2.10
MM5841	14.45
MM5865	7.95
CT7001	5.80
CT7002	8.95
CT7010	8.95
CT7015	7.25
MM5375AA/N	3.90
MM5375AB/N	4.95
7205	16.50
7207	7.50
7208	15.95
7209	4.95
DS0026CN	3.75
DS0056CN	3.75
MM53104	2.50

MICROPROCESSOR

6800	17.50
6802	24.95
8080A with data	8.95
8085	27.00
Z80A	19.75
8212	2.90
8214	8.00
8216	2.90
8224	2.90
8228	5.35
8251	8.50
8253	10.00
8255	9.25
8257	19.50
8259	19.50
CDP1802CD	19.95
CDP1802D	25.00
CDP1861	12.95
6820	9.95
6850	12.95
6502	12.50

IC SOCKETS

Solder Tin Low Profile PIN	1 UP	PIN	1UP
8	.15	22	.30
14	.18	24	.35
16	.20	28	.42
18	.27	36	.58
20	.29	40	.57

3 level wire wrap gold.
14 pin .25
2 level 14 pin ww .20

WIRE WRAP LEVEL 3

PIN		PIN	
14	.25	24	.86
16	.33	28	1.00
18	.57	40	1.23

UART/FIFO

AY5-1013	5.50
AY5-1014	7.50
3341	6.95

PROM

1702A	3.95
N82S23	2.95
N82S123	3.50
N82S126	3.75
N82S129	3.75
N82S131	3.75
N82S136	8.75
N82S137	8.75
2708	10.50
DM8577	2.90
8223	2.90
2716T1	29.50
2716 Intel	48.00

CRYSTALS

1 MHz	4.50
2 MHz	4.50
4 MHz	4.25
5 MHz	4.25
10 MHz	4.25
18 MHz	3.90
20 MHz	3.90
32 MHz	3.90
32768 MHz	4.00
1.8432 MHz	4.50
3.5795 MHz	1.20
2.0100 MHz	1.95
2.097152 MHz	4.50
2.4576 MHz	4.50
3.2768 MHz	4.50
5.0688 MHz	4.50
5.185 MHz	4.50
5.7143 MHz	4.50
6.5536 MHz	4.50
14.31818 MHz	4.25
18.432 MHz	4.50
22.1184 MHz	4.50

CONNECTORS

44 pin edge	2.75
100 pin edge	4.50
100 pin edge WW	5.25

KEYBOARD ENCODERS

AY5-2376	$12.50
AY5-3600	13.50
74C922	5.50
74C923	5.50
HD0165-5	6.95

IC Test Clips

	1	10
Red	.55	.47
Black	.55	.47

Keyer 8043 14.50
comp. w/spec./sock.

TRANSISTORS

2N1893	.40
2N2222A	.18
2N2369	.30
2N2904A	.20
2N2907A	.25
2N3053	.40
2N3638	.25
2N3643	.25
2N3904	.18
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2N4400	.25
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2N4402	.20
TIP31	.60
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DB25P	2.95
DB25S	3.95
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CLOCK MODULES Complete alarm clocks ready to hook up with transformer and switches. Very compact with .50" and .84" digits.

MA1002A, C or E .50"	**8.95**
102P3 Transformer	**2.25**
MA1010A, C or E .84"	**11.95**
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Special transformer and six switches when purchased w/module	**2.95**
MA1003 car module .3" green fluor. display	**15.95**

RESISTORS ¼ watt 5%

10 per type .03 1000 per type .012
25 per type .025 350 piece pack
100 per type .015 5 per type 6.75

KEYBOARDS

56 key ASCII keyboard kit	$67.50
Fully assembled	77.50
53 key ASCII keyboard kit	60.00
Fully assembled 70.00 Enclosure	14.95

LEDS

Red T018	.15
Green, Yellow T018	.20
Jumbo Red	.20
Green, Orange, Yellow Jumbo	.25
Cliplite LED Mounting Clips 8/$1.25 (specify red, amber, green, yellow, clear)	

CONTINENTAL SPECIALTIES in stock
Complete line of breadboard test equip.
MAX-100 8 digit Freq. Ctr. $128.95

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Portable Multimeter $18.00

DIGITAL THERMOMETER $48.50
Batt. oper. General purpose or medical 32°–230°F. Disposable probe cover ±.2° accuracy. Comp. Assy. in compact case. Switches from F° to C°.

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4K EPROM Kit	114.95
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Extender Board w/connector	12.50
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Additional Drive Kit	415.00

SPECIAL PRODUCTS

MM5865 Stopwatch Timer	9.00
PC board	7.50
Switches Mom. Pushbutton	.27
3 pos. slide	.25
Encoder HD0165-5	6.95
3 Digit Universal Counter Board Kit Operates 5–18 Volt DC to 5 MHz typ. .125" LED display	**10.50**
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Sinclair 3½ Digit Multimeter	**$59.95**
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6V 300 ma	3.25
12 Volt 300 ma transformer	1.25
12.6V CT 600 ma	3.75
12V 250 ma wall plug	2.95
12V CT 250 ma wall plug	3.50
24V CT 400 ma	3.95
10V 1.2 amp wall plug	4.85
12V 6 amp	12.95

DISPLAY LEDS

MAN1	CA .270	2.90
MAN3	CC .125	.39
MAN72/74	CA/CA .300	1.00
DL704	CC .300	1.25
DL707/DL707R	CA .300	1.00
DL727/728	CA/CC .500	1.90
DL747/750	CA/CC .600	1.95
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FND359	CC .357	.70
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9400		65V	3.00
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Opens shorted cells that won't hold a charge and then charges them up, all in one kit w/full parts and instructions. **$7.25**

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6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display, ROM monitor, fully expandable. $375.00. 4K Assembler $85.00, 8K Basic Interpreter $100.00. Power supply assembled in case $60.00.

Multi-voltage Computer Power Supply

8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12 option. ±5v, ±12v are regulated. Kit $29.95. Kit with punched frame $34.95. Woodgrain case $10.00.

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Convert your TV set into a high quality monitor without affecting normal usage. Complete kit with full instructions.

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Complete kit less case **$37.50**

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79 IC Update Master Manual $35.00

Complete IC data selector, 2500 pg. master reference guide. Over 50,000 cross references. Free update service through 1979. Domestic postage $3.50. Foreign $5.00. 1978 IC Master closeout $19.50.

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24K Static RAM Kit	423.00
32K Dynamic RAM Kit	310.00
64K Dynamic RAM Kit	470.00
8K/16K Eprom Kit (less PROMS)	**$89.00**
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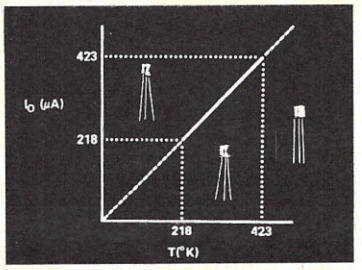
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Two terminal I.C. Temperature Transducer
ANALOG DEVICES AD590J is a two terminal device producing an output current proportional to absolute temperature. Laser triming produces ± 9°C maximum error without external calibration. Calibration can reduce maximum error to only ± 2°C over -55° to +150°C range. Sensitivity is 1uA/°K. Use with +4 to +30V supply as input to digital meter in thermometer applications. Excellent for remote applications due to the very high impedance. Comes in TO-52 metal can.

AD590J.....$3.49
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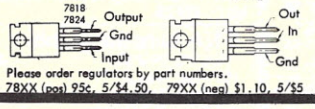
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3-TERMINAL VOLTAGE REGULATORS
TRI-TEK has become a major source for the 7800 and 7900 series 3-terminal regulators in TO-220 package. These PRIME parts are factory first quality!! At these prices, you can't afford retested fall outs. Available in the following voltages. Last 2 digits indicate voltage.

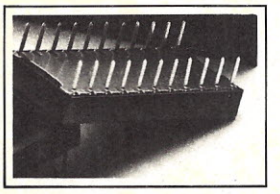
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7808		7908	7924
7812		7912	
7815			
7818			
7824			



Please order regulators by part numbers.
78XX (pos) 95c, 5/$4.50, 79XX (neg) $1.10, 5/$5

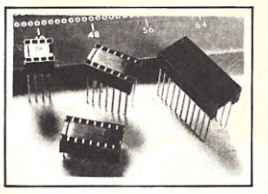
Socket Center



Texas Instruments

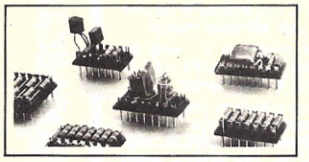
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SKT-0802	8 pin	.15	.14	.12	.115
SKT-1402	14 pin	.18	.18	.15	.135
SKT-1602	16 pin	.20	.19	.17	.150
SKT-1802	18 pin	.26	.25	.24	.185
SKT-2002	20 pin	.32	.31	.29	.210
SKT-2202	22 pin	.35	.34	.33	.235
SKT-2402	24 pin	.35	.34	.33	.250
SKT-2802	28 pin	.43	.42	.41	.300
SKT-4002	40 pin	.59	.57	.55	.430



3 LEVEL WIRE WRAP GOLD
Sockets include features most desired by the electronics industry - gold over nickel plating, closed entry - removable covers and replaceable pins.

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SKT-1800	18 pin	.68	.67	.57	.52
SKT-2000	20 pin	.90	.86	.74	.67
SKT-2200	22 pin	.93	.90	.80	.70
SKT-2400	24 pin	.95	.89	.78	.72
SKT-2800	28 pin	1.20	1.04	.99	.92
SKT-4000	40 pin	1.53	1.45	1.35	1.19



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Use for mounting diodes, resistors, jumpers, etc. Gold plated parts for ease of soldering and reliability.

	PLUGS			COVERS	
	1-24	25-49	50-99	1-24	25-99
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14 pin	.45	.40	.37	.10	.09
16 pin	.47	.46	.45	.10	.09
24 pin	.75	.70	.67	.15	.13
40 pin	1.20	1.05	1.02	.25	.22

78P05SC 5V 10A TO-3 Reg.....$12.95
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25 Pin RS-232 connector Male..... $2.25
25 Pin RS-232 connector Female $3.25
DB-51226 Hood for RS-232 connector ..... $ 1.39
D-20418 Screw Lock assembly ..... $ 1.19
4801 4KX1 Static RAM $8.95, 8/ $60.00
4804 1KX4 Static RAM $8.95, 8/ $60.00

MICRO PROCESSOR COMPATIBLE A/D CONVERTERS
National Semi ADC3511 and 3711 are CMOS monolithic A/D converters. Pluse modulation analog-to-digital conversion is used and requires no external precision components except the reference voltage.

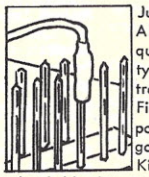
Single 5 volt operation. Operation with an isolated supply allows conversion of either polarity. Sign is automatically determined and indicated on the sign pin.

The ADC3511 and 3711 have been designed to provide address BCD data and are intended for use with micro processors and other digital systems. BCD digits are selected on demand via 2 Digit Select inputs. Digit Select inputs are latched. Start conversion input and conversion complete output are included on both types.

FEATURES
- .Single 5V Supply
- .ADC3511 3½ digits (0 to ± 1999 counts)
- .ADC3711 3¾ digits (0 to ± 3999 counts)
- .Addressed BCD Outputs
- .Easily interfaced to micro processor
- .TTL compatible

ADC-3511 (3-1/2 digit) $12.95
ADC-3711 (3-3/4 digit) $14.95
Spec for both parts..... .80

POWER OP AMP
250mA output current capability. Operates on as low as 3V. Input parameters are programmable for system optimizing. Electronic shut down allows output to float. Packaged in 8 pin mini-dip.
LM13080N..... $1.94
Specs and applications..... .60



Jumper Kits for .025 Square Posts. All material for making jumpers for quick circuit changes and prototyping. Use for breadboarding, trouble shooting, field modifications. Fits standard IC socket wire/wrap posts. Excellent wiping action on gold plated box contacts. Kit contain 10 box contacts, heat shrinkable sleeving, and 5 feet of wire plus instruction sheet.
JCK-5101....(5 double jumpers)$2.75, 4 kits/$10.00

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uDP416 16K Dynamic RAM (300nS) 8/ $128.00
6502 uProcessor..... $10.95

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Dozens of others-too many to list here and adding more each issue.

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TL497C SWITCHING REGULATOR
Switching regulator chip can convert from one voltage to another-either up or down!! Use this one to get positive or negative 12V from your +5V supply for those MOS parts. Starting with anywhere from +4.5V to +12V you can get from +30V down to -25V out. Adjustable output at up to 500mA. We are offering the chip plus a miniature inductor needed for the converter and spec sheet for only $9.50.
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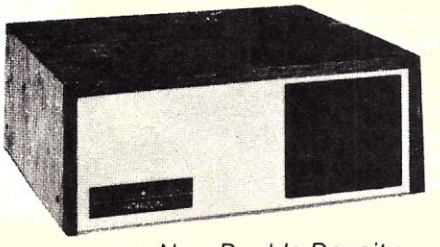
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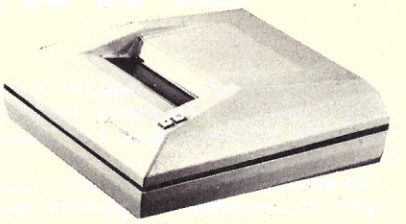
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fantastic new Xitan Disk Controller Board single and double density, handles mini- and standard-size drives simultaneously, complete with CP/M compatible DOS and Xitan disk BASIC. Assm./tested

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Assembled & Tested	$459	309
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450ns, Assembled	334	304
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OUR PRICE: $569

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TDL SMB BOARD

Provides for Zapple ROM, 2K RAM, parallel interface, 2 serial interfaces, and tape cassette interface.

Bare Board only, w/documentation	$ 49.95
Complete Kit	147.50
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None of above include Zapple ROM or RAM.

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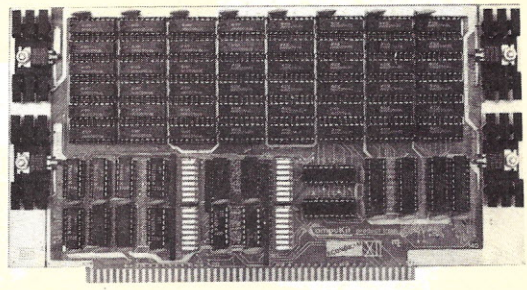
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YES !! Godbout has S-100 BANK SELECT BOARDS !

We're happy to announce the new CompuKit™ memories, each with two totally independent, individually selectable and addressable banks. These are **low power**, completely **static**, 4 MHz boards that offer **Econoram** quality in a brand new format.

Our memory boards are generally available in 3 forms: **unkit** (sockets, bypass caps pre-soldered in place for easy assembly); **assembled and tested**; or qualified under the **Certified System Component (CSC)** high-reliability program (200 hour burn-in, guaranteed 4 MHz operation over the full commercial temperature range, and immediate replacement in event of failure within 1 year of invoice date).



Name	Storage	Buss	Addressable on	Design	Unkit	Assm	CSC
Econoram XII-16™	16K X 8	S-100	8K boundaries	static	**$369**	**$419**	**$519**
Econoram XII-24™	24K X 8	S-100	8K boundaries	static	**$479**	**$539**	**$649**
Econoram XIII™	32K X 8	S-100	16K boundaries	static	**$629**	**$699**	**$849**

. . . AND WE STILL HAVE THE BOARDS THAT MADE US FAMOUS, ALL THE WAY TO 32K:

Name	Storage	Buss	Design	Speed	Configuration	Unkit	Assm	CSC
Econoram II™	8K X 8	S-100	static	2 MHz	dual 4K	**$149**	**$164**	N/A
Econoram IV™	16K X 8	S-100	static	4 MHz	single 16K	**$295**	**$329**	**$429**
Econoram VI™	12K X 8	H8	static	2 MHz	1-8K, 1-4K	**$200**	**$270**	N/A
Econoram VII™	24K X 8	S-100	static	4 MHz	2-4K, 2-8K	**$445**	**$485**	**$605**
Econoram IX™	32K X 8	Dig Grp	static	4 MHz	2-4K, 1-8K, 1-16K	**$649**	N/A	N/A
Econoram X™	32K X 8	S-100	static	4 MHz	2-8K, 1-16K	**$599**	**$649**	**$789**
Econoram XI™	32K X 8	SBC	static	4 MHz	2-8K, 1-16K	N/A	N/A	**$1050**

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THE • FULL FUNCTION • DUAL CHANNEL I/O BOARD

$189 unkit, **$249** assembled & tested

Our new I/O board gives you unparalleled flexibility and operating convenience . . .we include features such as two independently addressable serial ports, real LSI hardware UARTS for minimum CPU housekeeping, full RS232C, current loop (20 mA) and TTL signals on both ports, crystal controlled Baud rates up to 19.2 KBaud, transmit and receive interrupts on both channels, industry standard RS232 level converters with five RS232 handshaking lines per port, optically isolated current loop with provisions for both on board and off board current sources, full feature operation with either 2 or 4 MHz systems, low power consumption (+8V @ 350 mA typ; +16V @ 70 mA typ; −16V @ 55 mA typ), no software initialization required for board operation (although board parameters may be altered by software) . . . and much more.

Amazingly enough, all these features won't cost you more than other types of I/O boards that do a whole lot less. Want complete information? Just write, and we'll be glad to tell you all about it.

16K MEMORY EXPANSION SET $109 (3/$320)

For **Radio Shack-80, Apple, Sorcerer** machines. 250 ns chips for 4 MHz operation, DIP SHUNTS, 1 year limited warranty. Includes easy-to-follow instructions.

ACTIVE TERMINATOR KIT $29.50

Our much imitated design plugs into any S-100 motherboard to treat the S-100 buss as the RF system it really is, thereby reducing noise, glitches, ringing, overshoot, and other buss-related problems. Improves reliability of data transfer, while saving power compared to standard passive termination systems.

11 SLOT MOTHERBOARD UNKIT $90

Includes 11 edge connectors soldered in place for simplified assembly as well as active termination for reliable data transfer with energy efficiency. Dimensions: 8.5″ × 11″.

18 SLOT MOTHERBOARD UNKIT $124

Same as above, but 18 slot version. Dimensions. 8.5″ × 16.7″.

JUST IN: AN EXCITING NEW CHIP FROM WESTERN DIGITAL, the 1791 MOS LSI dual density disc controller chip. Prime part! With pinout and data, only **$59.**

TERMS: Allow 5% shipping, excess refunded. Cal res add tax. VISA®/Mastercharge® call our 24 hour order desk at **(415) 562-0636.** COD OK with street address for UPS (UPS COD charge applies). Prices good through cover month of magazine.

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✓G4

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LX303

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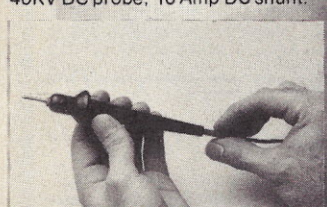
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Removable cover stores test lead set furnished as part of the unit



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SPECIFICATIONS:
DC VOLTS (5 RANGES): 0.1mV to 1000V; Accuracy ±0.5% rdg ±0.5% f.s.; Input imped: 10MΩ; Max. input 1kV except 500V on 200mV range.
AC VOLTS (40Hz to 5kHz): 0.1V to 600V; Accuracy: ±1.0% rdg ±0.5% f.s. (—2dB max. at 5kHz); Max. input: 600V.
RESISTANCE (6 LOW POWER RANGES): 0.1Ω to 20MΩ; Accuracy: ±0.5% rdg ±0.5% f.s. (±1.5% rdg on 20MΩ range); input protected to 120VAC all ranges.
DC CURRENT (6 RANGES):.01nA to 100mA; Accuracy: ±1.0% rdg ±0.5% f.s.
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MICROPROCESSOR EQUIP/CASE/KEYBOARD

$28.88 EA.



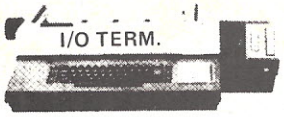
RUE equipment case originally contained a 9" video monitor & other microprocessor stuff. Good size is suitable for most hobbyist applications - give your minicomputer that professional look! Unit has smoked plastic translucent screen, 57 key alphanumeric keyboard terminated in 2 14 pin dip connectors (no decoding circuitry, but you can easily add one of the many IC encoder chips available, such as our MCS1007), and anodized aluminum pan in base. Dimensions: case O.D. 17" wdx 22 1/2"dp. x 12" hg.; base pan I.D, 15¾" wd. x 20-7/8" dp. x 1½" space inside case Wd. x 14" dp. x 11½" hg (slopes). Sh. Wt. 14 Lbs. . . 9110134 . . $28.88 5 for $133.88 . . 9110134. . $133.88/5

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We supply all electrical and electronic parts, you supply labor & mechanical parts, tools, & case.
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I/O TERM.



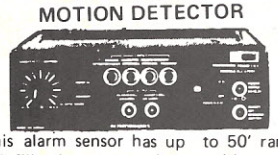
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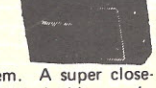
This unit operates on 115 VAC; used for taking up all kinds of punched tape. Spool is 10.5" dia., original price was over $100.00. Qty. ltd.
Sh.Wt. 7 lbs. . . . . 8A8-0328. . . . . $16.88
3 for $47.88 . . . . .8A8-0328 . . . . $47.88/3

ULTRASONIC MOTION DETECTOR



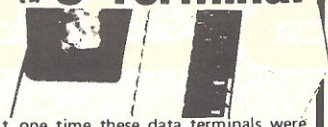
This alarm sensor has up to 50' range and fills the protected area with an energy screen that cannot be seen, felt or heard. Triggers your alarm whenever burglar moves through detector field. Mounts on ceiling, wall desk, shelf etc. Optional delay mode, auto-reset. Operates on 12.5 VDC. A close-out that originally sold for $179.00 3 Lbs. Qty ltd.
8D30336 . . . . . $49.88
ALSO AVAILABLE:
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* Connector Kit . . . 8D0504 . . . .$1.50

TOUCH SWITCH ALARM



NEW packaged system. A super close-out item. Protects your valuables; gun's, CB's, stereo equipment, test equipment, etc . . . . . List Price $22.88
Sh. Wt 1 Lb . . . . .8MI0474 . . . . .$7.88
3 for $22.88. . . .8MI0474 . . . $22.88/3

I/O Terminal



At one time these data terminals were used by stock brokers for keeping track of stock quotations. They tied in to a central system which has now been updated, leaving these surplus units behind.

Use this unit as a basis for building your own computer input/output station or to build a compact scope . . . or simply take it apart for the components within.

Sold complete or in parts, prices and descriptions listed below:

† **3" CRT, with Hi-volt. supply** (+3315 vdc; −1730 vdc), and low-volt. supply +440V; +225V; +125V; +28V; +1.2V; +0.6V; 6.3VDC; 6.3VAC. Also - **ramp generator card** & some drive circuits (15 Lbs.) $17.50

† **50 key Block keyboard,** with diode matrix on 2 cards.(5 Lbs.) $12.50

† **Handsome desk-top, slope front case,** suitable for up to an 11" CRT, overall 10½w x16d x9"h,(10 Lbs.) $7.50

† **Plus:** 3 wire line cord, brown, 7'lg for $1.00; 14 wire connector cable for $2.50.

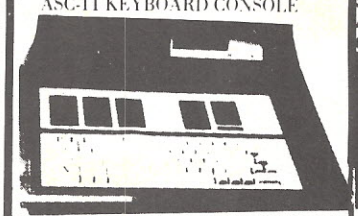
† **COMPLETE UNIT** Sh. Wt. 35 Lbs. **6NB60336** $29.95

† Also available is a **complete tech. manual** covering operating procedure, theory disassembly (& reassembly), trouble-shooting techniques and schematics. With complete unit - **$1.00** or sold separately for **$3.50** each. Sh. Wt. 8 oz.

WHEN ORDERING:
Specify part, use order no. 6NB60336

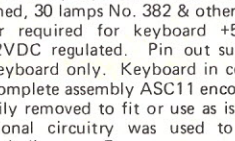
Visit our Retail Stores 119 Foster St., Peabody, Mass. 01960 or our NEWEST store-THE TOWNE DUMPE, INC., next to WOOLCO, 777 Willow St., Manchester, New Hampshire.

ASC-11 KEYBOARD CONSOLE



This Honeywell No. 74100903-001 ASC11 encoded microswitch data entry format keyboard. Comes with fully populated I.C. boards. Some 100 I.C.'s, 7100 & 71400 series, or some are dot matrix I.C.,s, LSI chips TMC 4907 - a 4 mhz crystal, a Mostek MK2002, plugs into a wire wrap board of 120 sockets. Also 2-large heat sinks, 4-2N3055 xistors, 2-2N3668, 4-jumper cables with dip plugs attached, 30 lamps No. 382 & other stuff. Power required for keyboard +5VDC, to 12VDC regulated. Pin out supplied for keyboard only. Keyboard in console is a complete assembly ASC11 encoded & is easily removed to fit or use as is. The additional circuitry was used to drive status indicators; Format, program level, check & display etc. Console size: 19" wd.x16"dp.x8" hg. rear, front slopes to 2 3/4"hg. Removed from equipment. Good to excellent condition.
Sh. Wt. 16 Lbs . . . 8W0584. . . . $68.88
3 for $188.88 . . . 8W0584 . . . $188.88/

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Neat new closed-circuit alarm board will latch a relay if the alarm circuit is opened. This unit operates on 12-VDC at such a low price, it makes a perfect compact alarm component. With Data. Qty Ltd.
Sh. Wt. 6 oz.. . . . 8K30267 . . . .$2.88
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SPECIAL!



"AA" NiCad 8-PACK

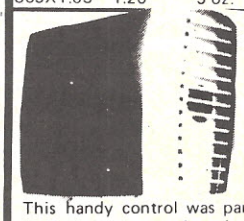
NEW! 8 "AA" cells in handy package, gives 10V Split into single cells for 1.25V ea.
8 oz/pack. . . . 8V20305 . . . $8.00/pack

RECHARGEABLE 1.25V



1.25V per cell. Used, good condition Sizes are AA-oversize, & sub-C (check dimensions).

Size (in).	Amp . . Hr	Sh. Wt.	Order No.
365X1.91	.60	4 oz.	7V70468
865X1.63	1.20	5 oz.	7V70470

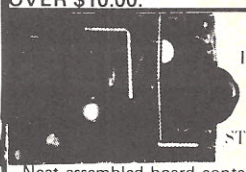


REMOTE CONTROL SYSTEM

Ultrasonic

This handy control was part of an Admiral remote control package for color TV. The original functions were On-Off, volume, VHF-UHF, and channel select. Receiver contains 3-relays and one four position stepping relay. Also includes a complete data pkg. Control section operates on 115 VAC. Good for toys, garage door openers, TV, stereo systems or any of those STAR TREK inovations you would like to make on your own. (Energize or de-energize your alarm system remotely. Range 30' Transmitter requiares AA cell (not included). Qty ltd. . . . . .
Sh. Wt 1 Lb. 8C30372 **$25.00/Set**
3 for $69.88 . . . .8C30372 . . . $69.88/3

SPECIAL OFFER - MENTION THIS AND TAKE 10% OFF ANY ORDER OVER $10.00.



16/8 WATT STEREO AMP.

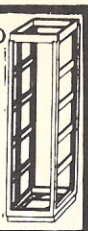
Neat assembled board contains all solid state components. Contains a DARLINGTON drive, push-pull output, all with complementary power tab transistors & mounted to lg. heat sinks. Accepts input from tape decks, magnetic or ceramic phono cartridges, mikes, etc. Requires a 48V xformer & 1 meg volume control. (not supplied) Output 8 into 8 ohms. (supplied with data).
Sh. Wt. 1 Lb. . . . .8Y0513 . . . .$5.78
*Stereo Xformer . . . 8G0530 . . .$2.88
*Stereo Pkg.-16 watts W/xformer & Cont. Sh. Wt. 4 Lbs. .8E0544 . .$13.88

COMPUTER STUFF



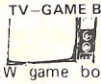
TTY . . . MD33 . . . ASR . . . $348.88
TTY . . . MD33 . . . KSR . . . $288.88
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TV-GAME BOARD good for 5V, 1A P.S., TV-COMPUTER DISPLAY INTERFACE



NEW game board, just off production run. These boards contain a 5V, 1A power supply (less xformer); a "TV-computer interface "(modulator), plus 16 or 20 "74L series IC's & a handful of other components. Complete with schematic for a TV Tennis/Handball game, etc. Instructions are included for using the 5V 1A power supply. **TV-Interface**
Sh. Wt 8 oz. . . . . .8T30322 . . . . **$6.88**
3 for $17.88. . . . .8T30322 . . . $17.88/3
† TRANSFORMER for power supply above.
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Sh. Wt. 6 oz.	**9C0043**	**$1.50/2**
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3-Line, & 11 Line, call directors with rotary dial. Reconditioned, Please state choice!
Sh. Wt. 10 Lbs. .3 Line. 8C0277. $28.88
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ALSO: TOUCH TONE-PAY STATION TELEPHONES . . .8C30273 . . . $69.88



AD/2-WAY LOUDSPEAKER KIT SAVE 65%....

This neat accustic suspension system with 8" woofer, 3 1/2" super horn, Piezo tweeter, Freq. Resp. 25 Hz. To 25 Khz. Walnut vinyl cabinets x 7½"Hg. x 11¼"Dp. Max. power 60 watts, Imp. 9 ohms. Kit includes 2-enclosures, 2-8" woofers, 2-Piezo tweeters, grill cloth, terminals, accoustic dampening, Inst. assembly.
DO-IT-YOURSELF & SAVE! This system listed for $81.00ea.
Sh. Wt. 38Lbs. . .9Y0005. . $68;88/Pr.

POSTAGE: Please add postage, 1lf material is F.O.B. Peabody, Ma. No C.O.D.'s please. Massachusetts Residents add 5% sales tax.

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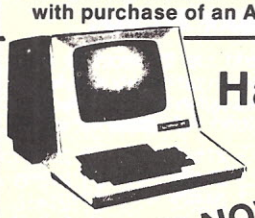
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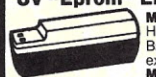
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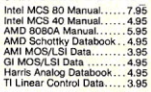
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AMD9140/41	10.95	10.25	9.25
AMD9130/31	12.95	11.95	10.25
FSC 460:46416K CCD Only		$18.95 Each	
1101	1.95	1.75	1.25
P2125/93425 (45 ns.)	7.95	7.35	7.25
6508 1K x 1 CMOS	7.95	7.95	7.25
6518 1K x 1 CMOS	7.95	7.95	7.25
74S189 64 bit Ram	3.95	3.25	2.50
8155 I/O w/Ram 22 Pin			
2147 Low Power 4K Static	14.95 ea.		

CHARGE COUPLED DEVICES

16K CCD - First time offered Fairchild 460 CCD 16K Memory (now you can experiment with CCD technology at a reasonable price. 17 page Application note supplied with each order. Quantity limited)

$18.95 each (reg. 43.00)

CRYSTALS

Microprocessor Timebases TV Game

Frequency	Price	Frequency	Price
1.0MHz	5.85	6.0MHz	$ 4.95
1.8432	4.95	6.144	4.95
2.0MHz	5.85	6.5536	4.95
2.01MHz	2.95	10.0MHz	4.95
2.097152MHz	5.85	13.0MHz	4.95
2.4576MHz	5.85	14.31818	4.95
3.579545MHz	1.50	18.0MHz	4.95
4.0MHz	4.95	18.432MHz	5.95
4.194304MHz	5.95	20.0MHz	4.95
4.91520MHz	5.95	22.1184MHz	5.95
5.0MHz	4.95	27.0MHz	5.95
5.0688	4.95	36.0MHz	5.95
5.7143MHz	5.95	48.0MHz	5.95
		100KC	12.95

DISPLAYS/OPTO/LED'S

★ 7 SEGMENT ★ CALC ★ CLOCKS ★

DL 704 (CC), DL 707 (CA) .300" Red	.99
FND 357 (CC) .357" Red	.99
FND 500/503 (CC) .500" Red	.99
FND 507/510 (CA) .500" Red	.99
FND 800/803 (CC) .800" Red	1.75
FND 807/810 (CA) .800" Red	1.75
XAN 3062 .500" Green	1.15
HPS0852-7731 (CA) .300" Red	.99
9 Digit Bubble Mini Calc. Display	.99
9 Digit Panaplex Display .400"	.99
9 Digit Fluorescent .300"	.99
MA1003 7/8" Auto Clock Module	**15.95**
Bezel for MA1003 w/Red Filter	4.95
MA1002A LED 12 hr. Clock Module	10.95

★ HEX DISPLAYS ★ ENCODED DISPLAYS ★

HP 5082-7340 Red Hexidecimal	15.95
HP 5082-7300 Red Numeric	14.95
TIL 306 Numeric w/Logic	8.95
TIL 308 Number w/Logic	8.95
TIL 309 Number w/Logic	8.95
TIL 311 Hexadecimal	12.95
MAN 2A .320" Red Alpha-Numeric	5.95
MAN 10A .270" Red Alpha-Numeric	8.95

★ LED'S ★ OPTOISOLATERS ★

LEDS Red, Yellow, Green .185	5/1.00
MCT 2 Photo XSTR HFE 250, 30V	.99
4N25 Photo XSTR HFE 250, 30V	1.29
4N33 Photo Darlington	1.75
FPT 1108 Photo XSTR Flat Lense	**SALE 4/1.00**

ATTENTION KIM USERS

KIMSAI-expansion to S-100	125.00 Kit/165.00
KIMSI to KIM Connector	5.75/pair
KIM 1 6502 Single Board Computer	179.00
KIM 1 Power Supply	59.95
KIM Memory Plus - (consists of 8K Ram, 8K2716 Eprom, Programmer,I/O etc.)	245.00

KIM SOFTWARE

- Please package (cassette) 12 games. 16.95
- Help Editor package (cassette) 16.95
- Help Mailing List pkg. (cassette) 16.95
- Help Info Retrival pkg. (cassette) 16.95
- Microchess (cassette) 16.95
- Microaid Assembly/Disassem/Editor 27.95
- Microaid Source Listing (cassette) 27.95
- Tiny Basic for KIM (paper tape) 10.95

COMPUTER SPECIALS

WOW!

	LIST	SALE
HiPlot Plotter	1085.00	899.00
HiPlot Digitizer	795.00	735.00
Exidy w/32K	1395.00	1195.00
Apple II w/16K	1195.00	1045.00
Compucolor II w/16K	1695.00	1595.00
TEI PT208 (1 avail.)	4995.00	3995.00
Cromemco Sys III	5990.00	5395.00
Commodore Pet	795.00	765.00
Soroc IQ/120	995.00	895.00
ADM3A Assem.	995.00	829.00
Teletype 43	1349.00	1150.00
Centronics P-1	495.00	395.00
Centronics S-1	595.00	525.00

MONTHLY IC SPECIALS

LF13508 JFET Anlog Multi 8 bit	8.95		
ICM7208 Seven Decade Counter	17.95		
ICM7207 Oscillator Controller	6.95		
ICM7040 Precision Stot/Watch Timer	22.95		
ICL7107 3½ Digit A/D (LED)	14.95		
ICL8211 Voltage Reference	1.95		
LM390 Battery OP. Audio Amp	3/1.00		
LM1830 Fluid Detector	3/1.00		
LM1850 Ground Fault IC	3/1.00		
LM1800 Phase Lock Loop FM Stereo	3/1.00		
LM1820 AM Radio	3/1.00		
DS3625 Dual Mos Sense Amp	2.50		
1488/1489	4/19.95	10147 ECL Ram	9.95
1488/1489	2/1.99	NE561	5.00
22 Pin S/T Socket 10/1.00		LF356HBIFet	3/1.99
8223 Prom	2.95	MCM14505	8.95
6331-1 Prom	1.95	74S89	3/1.99
MK5014 Calc.	21.99	74107N	6/1.99
74141N	3/1.99	75452N	8/1.99
LM2917	2.25	741N-14	10/1.99
8T26/8T28	2.39	555CN	5/1.99
9614DC	9.95	556CN	3/1.99

ATTN TRS 80 USERS

- ★ 20/40 Pin Memory Expansion Conn ... $7.95
- ★ Add-on Mini Floppy Complete w/cable ... 395.00 Duals, 795.00, Triple, 1185.00, Quad, 1580.00
- ★ Electric Pencil for TRS 80..... 99.95
- ★ Custom TRS 80 Modifications, Send for Flyer

TRS 80 Level III BASIC (Microsoft on cassette) 49.95

SOCKETS

8 Pin W/W	.32	8 Pin S/T	.17
14 Pin W/W	.37	14 Pin S/T	.20
16 Pin W/W	.38	16 Pin S/T	.22
18 Pin W/W	.60	18 Pin S/T	.31
20 Pin W/W	.90	20 Pin S/T	.34
22 Pin W/W	.93	22 Pin S/T	.35
24 Pin W/W	.85	24 Pin S/T	.41
28 Pin W/W	1.15	28 Pin S/T	.49
40 Pin W/W	1.49	40 Pin S/T	.63

TEXTOOL ZERO INSERTION FORCE SOCKETS

16 Pin $ 5.50 24 Pin $7.50
40 Pin $10.25

CONNECTORS

DB25P (RS232)	3.25
DB25S Female	3.75
Hood	1.25
Set w/Hood, Sale	$6.50
22/44 W/W, S/T, KIM	2.95
43/86 W/W, S/T, MOT	6.50
50/100 S-100 Connector w/w	4.25
50/100 S-100 Connector s/t	3.25

CTS DIPSWITCHES

CTS206-4 $1.75	CTS206-8 $1.95
CTS206-5 $1.75	CTS206-9 $1.95
CTS206-6 $1.75	CTS206-10 $1.95
CTS206-7 $1.75	

LIVERMORE BASIC

ON 65K ROM
THAT'S RIGHT ON ROM!!!
OUR PRICE only $95.00

NAKED PC BOARD SALE

Z-80 CPU (Ithaca)	$34.95
8080A CPU	34.95
8K Static RAM (Logos)	21.95
16K Static RAM (2114)	29.95
32K Static RAM (2114)	49.95
Floppy I/O (Tarbell)	39.95
Cassette I/O (Tarbell)	29.95
8K Eprom (2708)	21.95
1702 Eprom Board	30.00
2708/2716 Eprom (Ithaca)	34.95
2708/2716 Eprom (WMC)	30.00
Realtime Clock	34.95
ACP Proto Bd. (3M Conn.)	27.95
Vector 8800 Proto	19.95
Vector 8803 11 slot MB	29.95
ACP Extender w/Conn	15.95
Video Interface (SSM)	27.95
Parallel Interface (SSM)	27.95
13 Slot MotherBoard (WMC)	32.95
9 Slot MotherBoard (WMC)	29.95
8 Slot Mother (expandable)	34.95

WAVEFORM GENERATORS

8038 Function Gen.	3.95
MC4024 VCO	2.45
LM566 VCO	1.75
XR2206 Function Generator	5.25

FLOPPY DISK I/O

1771-01 8" & Minifloppy	27.95
uPd372 Nec Floppy	49.95
1781 Dual Floppy	39.95
1791 Dual Floppy	44.95

TV INTERFACES

Pixie-Verter	8.50
TV-1 Video Interface	8.95
Microverter	15.00
M&R Modulator	15.00

ATTENTION PET USERS

BETSI-pet expansion to S100 ..... 105.00 Kit/160.00

PET Connector Kit. Includes (4) Connectors for memory expansion, IEEE 488 I/O, cassette I/O and parallel user port..... 7.95/set

Video Buffer (converts to Std. Video)..... 29.95
Petunia (Music Board) 29.95
Combo (Video & Petunia) 49.95
Beeper (signals tape load) 24.95

ATTENTION APPLE II USERS

Apple II w/16K	$1045.00
16K Upgrade Kit	89.95
Floppy Disk II w/Interface	595.00
Floppy Disk II	495.00
Firmware Card	180.00
Printer Centronics P-1 w/cont	595.00
Printer Centronics P-1	395.00
Printer Centr. 779 w/cont	1445.00
Apple II Proto Board	24.00
Parallel I/O Card	180.00
Communications I/O Card	180.00
Coresident Assembler Cass	19.95
Heuristics Robot Car	249.00
Heuristics 20A Speechlab	189.00
Dow Jones Stock Quote Pkg	25.00
AJ.A242 Coupler	325.00

I/O to transmit over existing wiring ..... 189.00 A/T

- ★ Trencom w/IO 40 col. printer $406.00
- ★ Lower case adapter 49.95

TV CHIPS

AY38550-1 6 Games Color w/8515	$8.95
AY38500-1 6 Games B/W	4.95
AY38515 Color Converter	2.95
AY38603-1 Roadrace Game	8.95
AY38605-1 Warfare Game	9.50
AY38606-1 Wipeout Game	9.50
AY38607-1 Shooting Gallery	9.50
AY38610-1 10 Games Color w/8615	9.50
AY38615 Color Converter*	3.95
AY38910 Dimn/Cricket Sound Generator	12.95
SN76477 TI Sound Generator	3.95
MM5320/21 TV Synch Gen	9.95
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All Shipments FCM or UPS. Orders under $100.00 add 5% handling and postage. Orders over $100.00 add 2.5% handling & postage. Mastercharge/Bankamericard/COD accepted w/25% deposit. California Residents add 6% tax. Foreign Orders add 8% handling. All parts prime factory tested guaranteed. Same day shipment. Add 25 cents for Data.

Retail pricing may vary from Mail Order Pricing. All pricing subject to change without notice.

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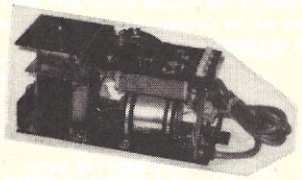
Retail Store Open Mon. – Sat.
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Santa Ana, CA 92705

WALLEN

ELECTRONICS CO. INC. Tel: (617) 588-6440-6441
108 SAWTELL AVE., BROCKTON, MASS. 02402

TEST EQUIPMENT
CONNECTORS-WIRE
ELECT. COMPONENTS

POWER SUPPLIES



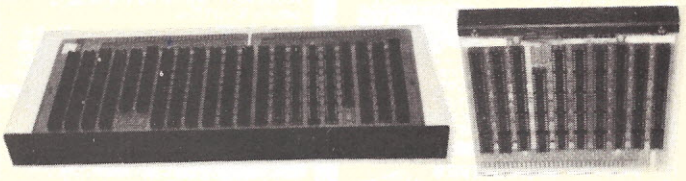
5 volts@8amps + 12 volts, 2 amps + 6 volts@75 MA. Ideal for Micro and Mini computers. These units have been removed from equipment and rechecked out and guaranteed. Power supply has a 3-wire line cord and fused. Spec: 10-1/2" x 5-1/2" x 4-1/2". Shipping weight 16 lbs.

REGULATED COMPUTER

37.50
2 FOR 70.00

Wire Wrap BOARDS

These boards are pre-wired and removed from equipment. Easy to unwrap for setting up your own board. Contains mostly 14-pin IC sockets with individual pin connections. Each board has VCC and ground planes.



Smaller board measures 6½" x 6" and has 40 to 50 sockets. PRICE $11.00 ea. 2/$20.00
Larger board measures 13½" x 6" and has 75 to 100 sockets. PRICE $17.50 ea. 2/$33.00

CRYSTAL
OSCILLATORS

Vectron type CO-23IT crystal freq. 4.9152, MHZ w/tuning option for accuracy of .0001%
1-1/2" x -1/2". R.F.E.



13.95

ROTRON Whisper Fans

115V, AC, 7 watts, 50-60 Hz. Guaranteed.
4-1/2" x 4-1/2" x 1-1/2". Removed from equipment, checked and guaranteed.

6.95

TEKTRONIX 535A OSCILLOSCOPE

Used equipment. Freq. DC to 15 Mhz. These scopes come w/B, D, K or L plug-in units. Checked out and operating.

$199 W/1 PLUG-IN

DUAL TRACE PLUG-INS
Model CA available. Checked out and operating.

$100

LINE CORDS—with ground wire. 6-ft. length, 16/3 type SJ

75¢

TRANSFORMERS ISOLATION/STEP-DOWN TYPE

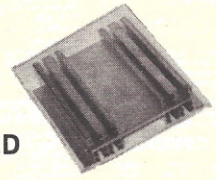
Primary: 230/115V, 50/60 CPS,
Secondary: VA output 250 V.

13.95 EACH

SEMI-CONDUCTOR COOLERS (heat sinks)

ALUMINUM BLANKS

NOT DRILLED



1.75 EACH

5" x 4¾" x 1¼"

ANODIZED ALUMINUM FOR TO-3 or TO-66 TRANSISTORS

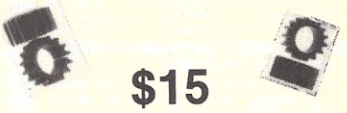
Chassis Mounting



20¢ EA

1 7/8" x 1 1/8"

For TO-5 series tansistors (gear type)

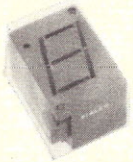


$15

SOLD IN PKG. OF 100s

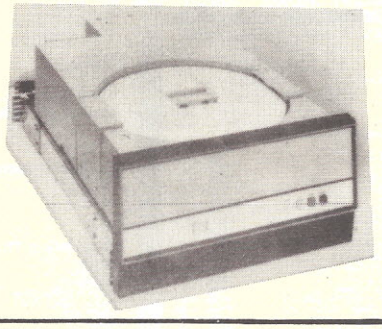
INCANDESCENT READOUT ASSEMBLY

Readouts assembled of the 710 series modules. Character 1" high w/lamps. Type No. 344. By Dialco.



2.75 each

Diablo System Disk Drive



SERIES 40 MODEL 43

100 tracks per inch, total capacity of 50 megabits, w/Model 429 power supply, sector counter, 24 sectors, 1 fixed disc, 1 removable disc, average access time 38 ms, P.P.M: 2400, dimensions: 10 5/16" high, fits in standard rack, equipped with full extension slides.

$2495

Minimum order $25.00. Items offered subject to prior sale, FOB, Brockton, Mass. Money order or check w/order. Shipping and handling add 5%. Shipments by parcel post or UPS. No CODs. Mass. residents add 5% sales tax.

TRS-80 Owners— Read this and save over $100.00



Introducing the Vista V80 Mini Disk System

- ☐ **23% MORE STORAGE CAPACITY** — Increases your usable storage capacity 23% from 55,000 to 67,800 bytes on drive one.
- ☐ **FASTER DRIVE** — Electronically equal to the TRS-80 Mini-Disk System, but up to 8 times faster (Track-to-track access in 5ms for the V80 versus 40ms for TRS-80).
- ☐ **DOES NOT VOID TRS-80 WARRANTY** — V80 also has 90-day warranty.
- ☐ **HERE'S WHAT YOU GET:** Minifloppy disk drive/Power Supply/Regulator board/Compact case
- ☐ **DOUBLE DENSITY FOR DOUBLE STORAGE** — The V80 will work with the Vista double-density expansion unit when available.
- ☐ **SHIPPED TO YOU READY TO RUN** — Simply take it out of the box, plug it in and you're ready to run.

Dealer inquiries invited

PLUS MORE GOOD NEWS – Vista has a new support team, new address, new telephone, and a new owner. Vista is now part of Advanced Computer Products.

ALSO AVAILABLE FROM THE NEW VISTA.

Vista V-200 Double Density Mini Floppy System with S-100 Controller, CPM on 5¼", power supply & case $699.00

Vista V-250 Dual Shugart 8" Floppy System with S-100 Controller, CPM, BASIC "E", power supply & slimline case..... $2199.00

Special Introductory Price:

$395.00

Vista V20

Vista Computer Company
1320 E. St. Andrews Place, Unit I
Santa Ana, CA 92705
(714) 751-9201
TWX 910-595-1565

Transistor Checker



— Completely Assembled —
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high-power PNP and NPN transistors. Size: 3¼" x 6¼" x 2"

"C" cell battery not included.

NEW!

Trans-Check $29.95 ea.

Custom Cables & Jumpers



NEW! NEW!

DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft.	2-DP25P	$15.95 ea.
DB25P-4-S	4 Ft.	1-DP25P/1-25S	$16.95 ea.
DB25S-4-S	4 Ft.	2-DP25S	$17.95 ea.

Dip Jumpers

DJ14-1	1 ft.	1-14 Pin	$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-24	1 ft.	2-24 Pin	4.95 ea.

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing



CONNECTORS

25 Pin-D Subminiature

DB25P (as pictured)	PLUG (Meets RS232)	$2.95
DB25S	SOCKET (Meets RS232)	$3.50
DB51226-1	Cable Cover for DB25P or DB25S	$1.75

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out — Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	$1.95
18/36	PINS (Solder Eyelet)	$2.49
22/44	PINS (Solder Eyelet)	$2.95
50/100 (.100 Spacing)	PINS (Wire Wrap)	$6.95
50/100 (.125 Spacing)	PINS (Wire Wrap) R681-1	$6.95



Solar Cells 2x2cm

- 0.4 volts
- 100mA
- 41 MW

Can be added in series for higher voltage or parallel for higher current.

#SC 2x2 $1.95 ea. or 3/$5.00

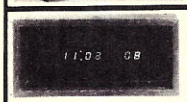
the 3rd Hand

MAKES CIRCUIT ASSEMBLY A BREEZE!

Lets you work with both hands. Sturdy Aluminum Construction. **$9.95 ea.**



- Clamp "3rd Hand" on edge of bench, table or workboard. Insert circuit board, position components.
- Flip circuit board to flat position for soldering and clipping.

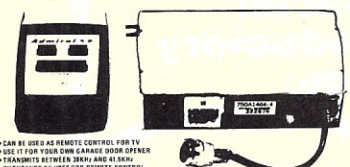


- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701

6-Digit Clock Kit $19.95

REMOTE CONTROL TRANSMITTER & RECEIVER



- CAN BE USED AS REMOTE CONTROL FOR TV
- USE IT FOR YOUR OWN GARAGE DOOR OPENER
- TRANSMITS BETWEEN 38KHz AND 41.5KHz
- THOUSANDS OF USES FOR REMOTE CONTROL APPLICATIONS
- TRANSMITTER USES A 9.5V BATTERY
- SCHEMATIC INCLUDED

$19.95

INSTRUMENT/CLOCK CASE



This case is an injection molded unit that is ideal for uses such as DVM, COUNTER, or CLOCK cases. It has dimensions of 4½" in length by 4" in width by 1-9/16" in height. It comes complete with a red bezel.

PART NO: IN-CC $3.49 each

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

8080A	CPU	$ 9.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	5.95
8238	System Controller	5.95
8251	Prog. Comm. 1/0 (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. 1/0 (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS—MISCELLANEOUS

Z80(780C)	CPU	$19.95
Z80A(780-1)	CPU	24.95
CDP1802	CPU	19.95
2650	MPU	19.95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95

SHIFT REGISTERS

MM500H	Dual 25 Bit Dynamic	$.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	1.95

UART'S

A-Y-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS

M-Z80	User Manual	$7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

ROM'S

2513(2140)	Character Generator(upper case)		$9.95
2513(3021)	Character Generator(lower case)		9.95
2516	Character Generator		10.95
MM5230N	2048-Bit Read Only Memory		1.95

RAM'S

1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	9.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin	14.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00

PROM'S

1702A	2048	FAMOS	$5.95
TMS2516	16K*	EPROM(Intel 2716)	49.95
(2716)	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I	16K**	EPROM	29.95
	**Requires 3 voltages, —5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

CSC CONTINENTAL SPECIALTIES PROTO BOARDS

Proto Board 203



A total ready-to-use power breadboard prototest device with a built-in regulated, short-proof power supply. Just plug-in and start building! 2 extra floating 5-way binding posts for external signals. Self-contained with power switch indicator lamp and power fuse. 24-14 pin DIP capacity. Attractive two-tone quality case. All metal construction. 9¼"L x 6½"W x 2¾"H 5 lbs.

PB 203 **$75.00**

Model Number	L x W x H (Inches)	Price
PB-6	6.0 x 4.5 x 1.4	$15.95
PB-100	6.0 x 4.5 x 1.4	$19.95
PB-101	6.0 x 4.5 x 1.4	$22.95

Proto Board 203A



All the features of the PB-203 plus additional power supply flexibility, provides 1%-Regulated 5VDC supply (same specifications as PB-203). Regulated separate +15VDC and —15 VDC 0.5A supplies, each with internally and independently adjustable output voltage. Ripple and noise of + and —15V supplies. 10mV at 0.25A.

PB 203A **$124.95**

Model Number	L x W x H (Inches)	Price
PB-102	7.0 x 4.5 x 1.4	$26.95
PB-103	9.0 x 6.0 x 1.4	$44.95
PB-104	9.8 x 8.0 x 1.4	$54.95

B&K PRECISION 3½-Digit Portable DMM



- Overload Protected
- .3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv, 1Va, 0.1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage 0-1000V/ AC Voltage: 0-1000V
Freq. Response: 50-400 HZ
DC/AC Current: 0-100mA
Resistance: 0-10 meg ohm
Size: 6.4" x 4.4" x 2"

Model 2800 $99.95

Comes with test leads, operating manual and spare fuse

Accessories:

AC Adapter BC-28	$9.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	7.50

CSC CONTINENTAL SPECIALTIES CORPORATION 100 MHz 8-Digit Counter



- 20 Hz-100 MHz Range
- .6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces, i.e. batteries, 110 or 220V with charger 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95

ACCESSORIES FOR MAX 100:

Mobile Charger Eliminator use power from car battery — Model 100 — CLA $3.95

Charger/Eliminator use 110 V AC — Model 100 — CAI $9.95

REGULATED POWER SUPPLY NEW!

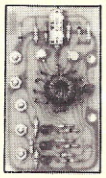
JE200 5V-1 AMP POWER SUPPLY



- *Uses LM309K
- *Heat sink provided
- *PC Board construction
- *Provides a solid 1 amp @ 5 volts
- *Can supply up to ±5V, ±9V and ±12V with JE205 Adapter
- *Includes components, hardware & instructions
- *Size: 3½"x5"x2"H

JE200 $14.95

JE205 ADAPTER BOARD — Adapts to JE200 — ±5V, ±9V and ±12V



- DC/DC converter w/ +5V input
- Toriodal hi-speed switching XMFR
- Short circ. protection
- PC Brd. construction
- Piggy-back to JE200 board
- Size: 3½"x2"x 9/16"h

JE205 $12.95

$10.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets — 25¢
1979 Catalog Available—Send 41¢ stamp

FREE 1979 Catalog

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The Incredible *"Pennywhistle 103"*



$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modern and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space; 2225 Hz for mark.
Transmit Channel Frequencies	Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 025 space, 2225 mark.
Receive Sensitivity	—46 dbm accoustically coupled.
Transmit Level	—15 dbm nominal. Adjustable from —6 dbm to —20 dbm.
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

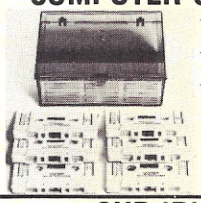
TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:

* 8 each UPD416-1 (16K Dynamic Rams) 250NS
* Documentation for conversion

TRS-16K $99.95

COMPUTER CASSETTES



- ★ 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- ★ PLASTIC CASE INCLUDED 12 CASSETTE CAPACITY
- ★ ADDITIONAL CASSETTES AVAILABLE #C-15-$2.50 ea

CAS-6 $14.95

(Case and 6 Cassettes)

SUP 'R' MOD II

UHF Channel 33 TV Interface Unit Kit



Wide Band B/W or Color System

- ★ Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, IRS-80, Challenger, etc.

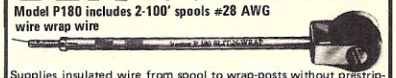
MOD II is pretuned to Channel 33 (UHF).

- ★ Includes coaxial cable and antenna transformer.

MOD II $29.95 Kit

SLIT-N-WRAP

Model P180 includes 2-100' spools #28 AWG wire wrap wire



Supplies insulated wire from spool to wrap-posts without prestripping and precutting using "daisy chain" method.

Model P180 Tool $24.50

P180A	Replacement Bit	$12.95
W28-2	Replacement wire (3 spool pkg.)	$2.75 ea.

Specify color: A-green B-red C-clear D-Blue

IDEAL FOR TRS 80 CASSETTE CONTROLLER

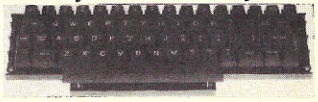
"Plug/Jack interface to any computer system requiring remote control of cassette functions"

The CC100 controls cassette motor functions, monitors tape location with its internal speaker and requires no power. Eliminates the plugging and unplugging of cables during computer loading operation from cassette.



#CC-100 $29.50

63-Key Unencoded Keyboard



This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK **$29.95/each**

Hexadecimal Unencoded Keypad



19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **$10.95/each**

7400 TTL

		SN7470N	.29		
		SN7472N	.29		
SN7400N	.16	SN7473N	.35	SN74160N	.89
SN7401N	.18	SN7474N	.35	SN74161N	.89
SN7402N	.18	SN7475N	.49	SN74162N	1.95
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SN7405N	.20	SN7480N	.50	SN74165N	.89
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SN7408N	.20	SN7485N	.79	SN74170N	1.59
SN7409N	.20	SN7486N	.35	SN74172N	6.00
SN7410N	.18	SN7489N	1.75	SN74173N	1.25
SN7411N	.25	SN7490N	.45	SN74174N	.89
SN7412N	.25	SN7491N	.59	SN74175N	.79
SN7413N	.40	SN7492N	.43	SN74176N	.79
SN7414N	.70	SN7493N	.43	SN74177N	.79
SN7416N	.25	SN7494N	.65	SN74179N	1.95
SN7417N	.25	SN7495N	.65	SN74180N	.79
SN7420N	.20	SN7496N	.65	SN74181N	1.95
SN7421N	.29	SN7497N	3.00	SN74182N	.79
SN7422N	.39	SN74100N	.89	SN74184N	1.95
SN7423N	.25	SN74107N	.35	SN74185N	1.95
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SN7430N	.20	SN74123N	.49	SN74192N	.79
SN7432N	.25	SN74125N	.49	SN74193N	.79
SN7437N	.25	SN74126N	.49	SN74194N	.89
SN7438N	.25	SN74132N	.75	SN74195N	.69
SN7439N	.25	SN74136N	.75	SN74196N	.89
SN7440N	.20	SN74141N	.79	SN74197N	.89
SN7441N	.89	SN74142N	2.95	SN74198N	1.49
SN7442N	.49	SN74143N	2.95	SN74199N	1.49
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SN7445N	.75	SN74147N	1.95	SN74279N	.79
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20% Discount 100 pcs combined order 25% -1000 pcs combined order

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CD4001	.23			CD4071	.23
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CD4006	1.19	CD4029	1.19	CD4076	1.39
CD4007	.25	CD4030	.49	CD4081	.23
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CD4012	.25	CD4042	.99	MC14409	14.95
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CD4015	1.19	CD4046	1.79	MC14419	4.95
CD4016	.49	CD4047	2.50	MC14433	19.95
CD4017	1.19	CD4048	1.35	MC14506	.75
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CD4019	.49	CD4050	.49	MC14562	14.50
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CD4022	1.19	CD4056	2.95	CD4510	1.39
CD4023	.23	CD4059	9.95	CD4511	1.29
CD4024	.79	CD4060	1.49	CD4515	2.95
CD4025	.23	CD4066	.79	CD4518	1.29
CD4026	2.25	CD4068	.39	CD4520	1.29
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74C00	.39			74C163	2.49
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74C04	.39	74C85	2.49	74C173	2.60
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74C42	1.95	74C154	3.00	74C925	8.95
74C48	2.49	74C157	2.15	74C926	8.95
74C73	.89	74C160	2.49	80C95	1.50
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LM304H	1.00	LM340T-6	1.25	LM741CN/H	.35
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LM308CN/H	1.00	LM340T-15	1.25	LM748N/H	.39
LM309H	1.10	LM340T-18	1.25	LM1310N	2.95
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LM310CN	1.15	LM358N	1.00	MC1488N	1.39
LM311N/H	.90	LM370N	1.95	MC1489N	1.39
LM312H	1.95	LM373N	3.25	LM1496N	.95
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LM319N	1.30	LM380CN	.99	LM2111N	1.95
LM320K-5	1.35	LM381N	1.79	LM2901N	2.95
LM320K-5.2	1.35	LM382N	1.79	LM3053N	1.50
LM320K-12	1.35	NE501N	8.00	LM3065N	1.49
LM320K-15	1.35	NE510A	6.00	LM3900N(3401)	.49
LM320K-18	1.35	NE529A	4.95	LM3905N	.89
LM320K-24	1.35	NE531H/V	3.95	LM3909N	1.25
LM320T-5	1.25	NE536T	6.00	MC5558V	.59
LM320T-5.2	1.25	NE540L	6.00	8038B	4.95
LM320T-8	1.25	NE544N	4.95	LM75450N	.49
LM320T-12	1.25	NE550N	1.30	75451CN	.39
LM320T-15	1.25	NE555V	.39	75452CN	.39
LM320T-18	1.25	NE556N	.99	75453CN	.39
LM320T-24	1.25	NE560B	5.00	75454CN	.39
LM323K-5	5.95	NE561B	5.00	75491CN	.79
LM324N	1.80	NE562B	5.00	75492CN	.89
LM339N	.99	NE565N/H	1.25	75493N	.89
LM340K-5	1.35	NE566CN	1.75	75494CN	.89
LM340K-6	1.35	NE567V/H	.99	RC4136	1.25
LM340K-8	1.35	NE570N	4.95	RC4151	2.85
LM340K-12	1.35	LM703CN/H	.69	RC4194	5.95
LM340K-15	1.35	LM709N/H	.29	RC4195	4.49

74LS00TTL

74LS00	.23			74LS138	.69
74LS01	.23			74LS139	.69
74LS02	.23	74LS47	.69	74LS151	.69
74LS03	.23	74LS51	.23	74LS155	.69
74LS04	.29	74LS54	.23	74LS157	.69
74LS05	.29	74LS55	.23	74LS160	.89
74LS08	.23	74LS73	.35	74LS161	.89
74LS09	.29	74LS74	.35	74LS162	.89
74LS10	.23	74LS75	.49	74LS163	.89
74LS11	.60	74LS76	.35	74LS164	.99
74LS13	.49	74LS78	.39	74LS175	.79
74LS14	.99	74LS83	.75	74LS181	2.49
74LS15	.29	74LS85	.99	74LS190	.89
74LS20	.23	74LS86	.35	74LS191	.89
74LS21	.29	74LS90	.49	74LS192	.89
74LS22	.29	74LS92	.59	74LS193	.89
74LS26	.29	74LS93	.59	74LS194	.89
74LS27	.29	74LS95	.79	74LS195	.89
74LS28	.29	74LS96	.89	74LS253	.79
74LS30	.23	74LS107	.35	74LS257	.69
74LS32	.29	74LS109	.35	74LS258	1.39
74LS37	.35	74LS112	.35	74LS260	.55
74LS40	.29	74LS123	.99	74LS279	.59
74LS42	.69	74LS125	.69	74LS367	.59
		74LS132	.79	74LS368	.59
		74LS136	.39	74LS670	1.95

EXCITING NEW KITS!

Regulated Power Supply
5 to 15 VDC

NEW



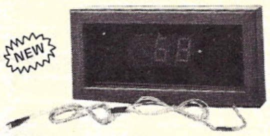
- *Full 1.5 amp at 5-10V output — Up to .5 amp at 15V output
- *Heavy duty transformer
- *3 terminal I.C. Volt. Reg.
- *Heat sink provided for cooling efficiency
- *PC Board construction
- *120 VAC input
- *Size: 3½"W x 5"L x 2"H

JE210 5 to 15 VDC **$19.95**

ALSO AVAILABLE:
JE900 Digital Stopwatch Kit . $39.95
JE301 6 digit Clock Kit $19.95

Digital Thermometer Kit

NEW



- Dual sensors—switching control for in-door/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsious reading
- Sim. walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 . . . . **$39.95**

JE730 4 digit Clock Kit . . . $14.95
JE2206B Func. Generator Kit . $19.95
JE747 Jumbo 6 dgt. clock kit $29.95

DISCRETE LEDS



.200" dia.			**.125" dia.**		
XC556R	red	5/$1	XC209R	red	5/$1
XC556G	green	4/$1	XC209G	green	4/$1
XC556Y	yellow	4/$1	XC209Y	yellow	4/$1
XC556C	clear	4/$1			
.200" dia.			**.185" dia.**		
XC22R	red	5/$1	XC526R	red	5/$1
XC22G	green	4/$1	XC526G	green	4/$1
XC22Y	yellow	4/$1	XC526Y	yellow	4/$1
.170" dia.			XC526C	clear	4/$1
MV10B	red	4/$1			
.085" dia.			**.190" dia.**		
MV50	red	6/$1	XC111R	red	5/$1
INFRA-RED LED			XC111G	green	4/$1
1/4"x1/4"x1/16" flat			XC111Y	yellow	4/$1
5/$1			XC111C	clear	4/$1

TIMEX T1001 LIQUID CRYSTAL DISPLAY
FIELD EFFECT



4 DIGIT — .5" CHARACTERS
THREE ENUNCIATORS
2.00" X 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive $7.95
T1001A-Reflective 8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.99	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.99	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL33B	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	1.30
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	2.10
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	2.10
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013T	2.15	CA3082N	2.00
CA2023T	2.56	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	.85	CA3401N	.49
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
9374 7 seg. C.A. LED driver	

CLOCK CHIPS

MM5309	$4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998A	4.95
MM5841	9.95

MOTOROLA

MC1408L7	$4.95
MC1408L8	5.75
MC1439L	2.95
MC3022P	2.95
MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS



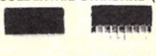
	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$.17	.16	.15	22 pin LP	$ .37	.36	.35
14 pin LP	.20	.19	.18	24 pin LP	.38	.37	.36
16 pin LP	.22	.21	.20	28 pin LP	.45	.44	.43
18 pin LP	.29	.28	.27	36 pin LP	.60	.59	.58
20 pin LP	.34	.32	.30	40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)



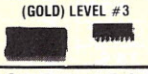
14 pin ST	$.27	.25	.24	28 pin ST	$ .99	.90	.81
16 pin ST	.30	.27	.25	36 pin ST	1.39	1.26	1.15
18 pin ST	.35	.32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)



8 pin SG	$.30	.27	.24	24 pin SG	$ .70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.65	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3



8 pin WW	$.39	.38	.31	22 pin WW	$ .95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	1.75	1.55	1.40

1/4 WATT RESISTOR ASSORTMENTS – 5%

		10 OHM	12 OHM	15 OHM	18 OHM	22 OHM		
ASST. 1	5 ea.	27 OHM	33 OHM	39 OHM	47 OHM	56 OHM	50 PCS	$1.75
		68 OHM	82 OHM	100 OHM	120 OHM	150 OHM		
ASST. 2	5 ea.	180 OHM	220 OHM	270 OHM	330 OHM	390 OHM	50 PCS	1.75
		470 OHM	560 OHM	680 OHM	820 OHM	1K		
ASST. 3	5 ea.	1.2K	1.5K	1.8K	2.2K	2.7K	50 PCS	1.75
		3.3K	3.9K	4.7K	5.6K	6.8K		
ASST. 4	5 ea.	8.2K	10K	12K	15K	18K	50 PCS	1.75
		22K	27K	33K	39K	47K		
ASST. 5	5 ea.	56K	68K	82K	100K	120K	50 PCS	1.75
		150K	180K	220K	270K	330K		
ASST. 6	5 ea.	390K	470K	560K	680K	820K	50 PCS	1.75
		1M	1.2M	1.5M	1.8M	2.2M		
ASST. 7	5 ea.	2.7M	3.3M	3.9M	4.7M	5.6M	50 PCS	1.75

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

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AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	14.95
HD0165	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.95

ICM CHIPS

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ICM7205	CMOS LED Stopwatch/Timer	19.95
ICM7207	Oscillator Controller	7.50
ICM7208	Seven Decade Counter	19.95
ICM7209	Clock Generator	6.95

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MCM6574	128 X 9 X 7 Math Symbol & Pictures	13.50
MCM6575	128 X 9 X 7 Alphanumeric Control Character Generator	13.50

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TL074CN	Quad Low Noise bi-fet Op Amp	2.49
TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
4N33	Photo-Darlington Opto-Isolator	3.95
MK50240	Top Octave Freq. Generator	17.50
DS0026CH	5Mhz 2-phase MOS clock driver	3.75
TIL308	.27" red num. display w/integ. logic chip	10.50
MM5320	TV Camera Sync. Generator	14.95
MM5330	4½ Digit DPM Logic Block **(Special)**	3.95
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AY-3-8500-1 and 2.01 MHZ Crystal (Chip & Crystal includes score display, 6 games and select angles, etc. **7.95/set**

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XR205	$8.40			XR2242CP	1.50
XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55	JE2206KA	14.95	XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	2.85
XR567CP	.99	XR2207	3.85	XR4194	4.95
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.30	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.39	XR2212	4.35	XR4739	1.15
XR1489	1.39	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12/1.00
				1N4003	200 PIV	1 AMP	12/1.00
1N746	3.3	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N3600	50	200m	6/1.00
1N757	9.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N759	12.0	400m	4/1.00	1N4154	35	10m	12/1.00
1N959	8.2	400m	4/1.00	1N4305	75	25m	15/1.00
1N965	15	400m	4/1.00	1N4734	5.6	1w	28
1N5232	5.6	500m	28	1N4735	6.2	1w	28
1N5234	6.2	500m	28	1N4736	6.8	1w	28
1N5235	6.8	500m	28	1N4738	8.2	1w	28
1N5236	7.5	500m	28	1N4742	12	1w	28
1N5242	12	500m	28	1N4744	15	1w	28
1N5245	15	500m	28	1N1183	50 PIV	35 AMP	1.60
1N456	25	40m	6/1.00	1N1184	100 PIV	35 AMP	1.70
1N458	150	7m	6/1.00	1N1185	150 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1186	200 PIV	35 AMP	1.80
1N4001	50 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369A	4/1.00	2N3706	5/1.00	2N5088	4/1.00
MPS2369	5/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2484	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2906	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2907	5/1.00	2N3724A	.65	PN5138	5/1.00
PN2907 Plastic	7/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100+		1-9	10-99	100+
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075
100 VOLT MYLAR FILM CAPACITORS							
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22
+20% DIPPED TANTALUMS (SOLID) CAPACITORS							
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				**Radial Lead**			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

DIODES/ZENERS

QTY.			
1N914	100v	10mA	.05
1N4005	600v	1A	.08
1N4007	1000v	1A	.15
1N4148	75v	10mA	.05
1N4733	5.1v	1 W Zener	.25
1N753A	6.2v	500 mW Zener	.25
1N758A	10v	"	.25
1N759A	12v	"	.25
1N5243	13v	"	.25
1N5244B	14v	"	.25
1N5245B	15v	"	.25

SOCKETS/BRIDGES

QTY.				
8-pin	pcb	.20	ww	.35
14-pin	pcb	.20	ww	.40
16-pin	pcb	.20	ww	.40
18-pin	pcb	.25	ww	.95
20-pin	pcb	.35	ww	.95
22-pin	pcb	.35	ww	.95
24-pin	pcb	.35	ww	.95
28-pin	pcb	.45	ww	1.25
40-pin	pcb	.50	ww	1.25
Molex pins .01		To-3 Sockets		.25
2 Amp Bridge		100-prv		.95
25 Amp Bridge		200-prv		1.50

TRANSISTORS, LEDS, etc.

QTY.		
2N2222	(2N2222 Plastic .10)	.15
2N2222A		.19
2N2907A	PNP	.19
2N3906	PNP (Plastic Unmarked)	.10
2N3904	NPN (Plastic Unmarked)	.10
2N3054	NPN	.45
2N3055	NPN 15A 60v	.60
T1P125	PNP Darlington	1.95
LED Green,	Red, Clear, Yellow	.15
D.L.747	7 seg 5/8" High com-anode	1.95
MAN72	7 seg com-anode (Red)	1.25
MAN3610	7 seg com-anode (Orange)	1.25
MAN82A	7 seg com-anode (Yellow)	1.25
MAN74	7 seg com-cathode (Red)	1.50
FND359	7 seg com-cathode (Red)	1.25

9000 SERIES

QTY.		QTY.	
9301	.85	9322	.65
9309	.35	9601	.20
9316	1.10	9602	.45

MICRO'S, RAMS, CPU'S, E-PROMS

QTY.		QTY.	
8T13	1.50	2107B-4	4.95
8T23	1.50	2114	9.50
8T24	2.00	2513	6.25
8T97	1.00	2708	10.50
74S188	3.00	2716 D.S.	34.00
1488	1.25	2716 (5v)	59.00
1489	1.25	2758 (5v)	23.95
1702A	4.50	3242	10.50
AM 9050	4.00	4116	11.50
		6800	13.95
MM 5314	3.00	6850	7.95
MM 5316	3.50	8080	7.50
MM 5387	3.50	8212	2.75
MM 5369	2.95	8214	4.95
TR 1602B	3.95	8216	3.50
UPD 414	4.95	8224	3.25
Z 80 A	22.50	8228	6.00
Z 80	17.50	8251	7.50
Z 80 PIO	10.50	8253	18.50
2102	1.45	8255	8.50
2102L	1.75	TMS 4044	9.95

C MOS

QTY.	
4000	.15
4001	.15
4002	.20
4004	3.95
4006	.95
4007	.20
4008	.75
4009	.35
4010	.35
4011	.20
4012	.20
4013	.40
4014	.75
4015	.75
4016	.35
4017	.75
4018	.75
4019	.35
4020	.85
4021	.75
4022	.75
4023	.20
4024	.75
4025	.20
4026	1.95
4027	.35
4028	.75
4029	1.15
4030	.30
4033	1.50
4034	2.45
4035	.75
4037	1.80
4040	.75
4041	.69
4042	.65
4043	.50
4044	.65
4046	1.25
4048	.95
4049	.45
4050	.45
4052	.75
4053	.75
4066	.55
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4071	.25
4081	.30
4082	.30
4507	.95
4511	.95
4512	1.10
4515	2.95
4519	.85
4522	1.10
4526	.95
4528	1.10
4529	.95
MC 14409	14.50
MC 14419	4.85
74C151	1.50

LINEARS, REGULATORS, etc.

QTY.		QTY.		QTY.	
MCT2	.95	LM323K	5.95	LM380 (8-14 Pin)	1.19
8038	3.95	LM324	1.25	LM709 (8-14 Pin)	.35
LM201	.75	LM339	.75	LM711	.45
LM301	.45	7805 (340T5)	.95	LM723	.40
LM308	.65	LM340T12	.95	LM725	2.50
LM309H	.65	LM340T15	.95	LM739	1.50
LM309K (340K-5)	1.50	LM340T18	.95	LM741 (8-14)	.35
LM310	.85	LM340T24	.95	LM747	1.10
LM311D	.75	LM340K12	1.25	LM1307	1.25
LM318	1.75	LM340K15	1.25	LM1458	.65
LM320H6	.79	LM340K18	1.25	LM3900	.50
LM320H15	.79	LM340K24	1.25	LM75451	.65
LM320H24	.79	LM373	2.95	NE555	.45
7905 (LM320K5)	1.65	LM377	3.95	NE556	.85
LM320K12	1.65	78L05	.75	NE565	.95
LM320K24	1.65	78L12	.75	NE566	1.25
LM320T5	1.65	78L15	.75	NE567	.95
LM320T12	1.65	78M05	.75		
LM320T15	1.65				

– T T L –

QTY.		QTY.		QTY.		QTY.	
7400	.10	7482	.75	74221	1.00	74LS02	.30
7401	.15	7483	.75	74367	.95	74LS04	.30
7402	.15	7485	.55	75108A	.35	74LS05	.35
7403	.15	7486	.25	75491	.50	74LS08	.35
7404	.10	7489	1.05	75492	.50	74LS09	.35
7405	.25	7490	.45	74H00	.15	74LS10	.35
7406	.25	7491	.70	74H01	.20	74LS11	.35
7407	.55	7492	.45	74H04	.20	74LS20	.30
7408	.15	7493	.35	74H05	.20	74LS21	.35
7409	.15	7494	.75	74H08	.35	74LS22	.35
7410	.15	7495	.60	74H10	.35	74LS32	.35
7411	.25	7496	.80	74H11	.25	74LS37	.35
7412	.25	74100	1.15	74H15	.45	74LS38	.45
7413	.25	74107	.25	74H20	.25	74LS40	.40
7414	.75	74121	.35	74H21	.25	74LS42	.75
7416	.25	74122	.55	74H22	.40	74LS51	.45
7417	.40	74123	.35	74H30	.20	74LS74	.45
7420	.15	74125	.45	74H40	.25	74LS76	.50
7426	.25	74126	.35	74H50	.25	74LS86	.45
7427	.25	74132	.75	74H51	.25	74LS90	.65
7430	.15	74141	.90	74H52	.15	74LS93	.65
7432	.20	74150	.85	74H53	.25	74LS107	.50
7437	.20	74151	.65	74H55	.20	74LS123	1.20
7438	.20	74153	.75	74H72	.35	74LS151	.85
7440	.20	74154	.95	74H74	.35	74LS153	.85
7441	1.15	74156	.70	74H101	.75	74LS157	.85
7442	.45	74157	.65	74H103	.55	74LS160	.95
7443	.45	74161	.55	74H106	.95	74LS164	1.20
7444	.45	74163	.85	74L00	.25	74LS193	1.05
7445	.65	74164	.60	74L02	.20	74LS195	.95
7446	.70	74165	1.10	74L03	.25	74LS244	1.70
7447	.70	74166	1.25	74L04	.30	74LS367	.95
7448	.50	74175	.80	74L10	.20	74LS368	.95
7450	.25	74176	.85	74L20	.35	74S00	.35
7451	.25	74180	.55	74L30	.45	74S02	.35
7453	.20	74181	2.25	74L47	1.95	74S03	.25
7454	.25	74182	.75	74L51	.45	74S04	.25
7460	.40	74190	1.25	74L55	.65	74S05	.35
7470	.45	74191	1.25	74L72	.45	74S08	.35
7472	.40	74192	.75	74L73	.40	74S10	.35
7473	.25	74193	.85	74L74	.45	74S11	.35
7474	.30	74194	.95	74L75	.85	74S20	.25
7475	.35	74195	.95	74L93	.55	74S40	.20
7476	.40	74196	.95	74L123	.85	74S50	.20
7480	.55	74197	.95	74LS00	.30	74S51	.25
7481	.75	74198	1.45	74LS01	.30	74S64	.15
						74S74	.35
						74S112	.60
						74S114	.65
						74S133	.40
						74S140	.55
						74S151	.30
						74S153	.35
						74S157	.75
						74S158	.30
						74S194	1.05
						74S257 (8123)	1.05
						8131	2.75

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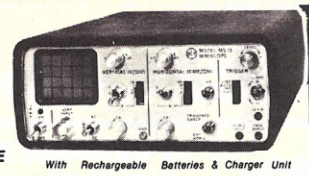
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SALE S-100 BUS EDGE CONNECTORS SALE



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R681-3 50/100 Cont. .125 ctrs. PIERCED SOLDER EYELET tails. GOLD. $7.53

Other Popular Edge Connectors

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CG-1 IMSAI Style Card Guides 5/$1.00
ATTN: OEM's and Dealers, many other connectors available call or quotation.

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3 LEVEL GOLD WIRE WRAP SOCKETS

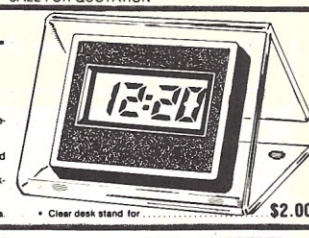


Sockets purchased in multiples of 50 per type may be combined for best price.

	1-9	10-24	25-99	100-249	250-999
8 pin*	.40	.36	.34	.31	.27
14 pin*	.45	.39	.37	.34	.32
16 pin*	.50	.42	.40	.36	.34
18 pin	.70	.60	.55	.50	.45
20 pin	.90	.80	.75	.65	.62
22 pin*	.95	.85	.80	.70	.65
24 pin	.95	.85	.80	.70	.65
28 pin	1.25	1.15	1.00	.95	.90
40 pin	1.65	1.45	1.35	1.20	1.10

All sockets are GOLD 3 level closed entry *End and side stacable. 2 level, Solder Tail, Low Profile, Tin Sockets and Dip Plugs available. CALL FOR QUOTATION

LIQUID CRYSTAL DIGITAL CLOCK-CALENDAR

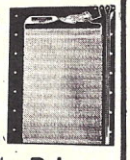


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- Small in size (2x2½x½)
- Push button for seconds release for date.
- Clocks mount anywhere with either 3M double-sided tape or VELCRO, included.
- 2 MODELS AVAILABLE:
  LCD-101, portable model runs on self-contained batteries for better than a year.
  LCD-102, runs on 12 Volt system and is back-lighted.
- LCD-101 or LCD-102 your choice ..... **$34.95 ea.**
- Clear desk stand for **$2.00**

- Kit includes 12 tantalum capacitors for +5, +12, −12 buses and insulated mounting spacers.
- Wiring side shown. Component side bare epoxy glass with white markings for component locations.
- G10 epoxy glass board with 2 ounce copper, solder plated and .038 diameter holes for leads.
- Solder mask with solder windows on etched circuits to avoid accidental short circuits.
- Mounts 11 receptacles with 100 contacts (2 rows) on .125 centers with .250 row spacing. Vector part number R681-2; or mounts 10 receptacles plus interconnections to smaller mother board for expansion.
- Includes etched circuits and instructions for option of active, pull-up, or floating terminations.
- Large buses: +5V and GND (10 AMPS), ± 12V or 16V (7 AMPS). Current ratings are per MIL-STD-275 with 10°C rise.
- Fits in Vector-pak enclosures.
- Fits in IMSAI 8080 microcomputer as expander board.

8803 MOTHER BOARD FOR S100 BUS MICRO-COMPUTERS

Vector



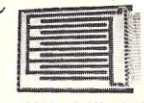
Price: $29.50

Vector **Plugboards**

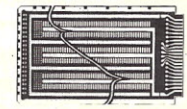


8800V
Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & hardware. 5.3" x 10" x 1/16"
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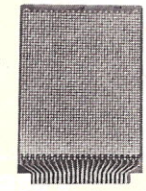
8801-1
Same as 8800V except plain; less power buses & heat sink.
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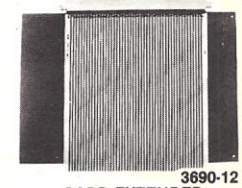
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3690 6.5" 22/44 pin .156 ctrs. Extenders $13.17



1/16 Vector BOARD
.042 dia holes on 0.1 spacing for IC's

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84P44	4.5x8.5"	$2.21	$1.99
169P44	4.5x17"	$4.52	$4.07
169P84	8.5x17"	$8.03	$7.23

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8K 450 ns
EPROM
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25 + *Call For Price*

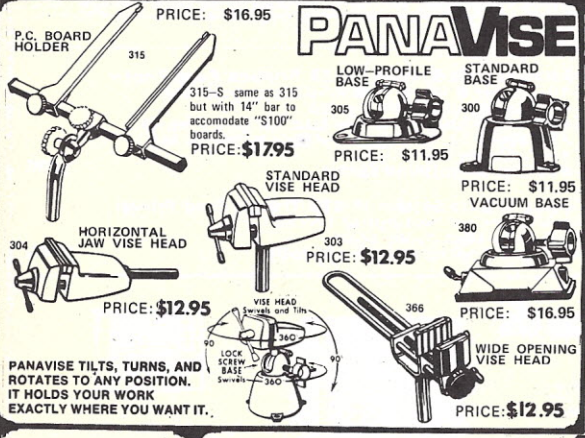
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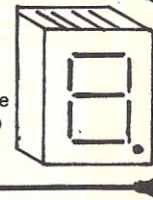


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½" 7 seg LED
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for .042 dia. holes
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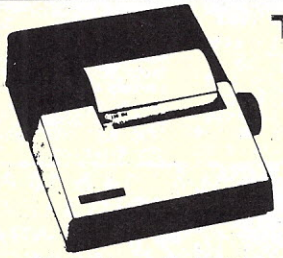
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Interface & Cable for TRS-80 $45.00

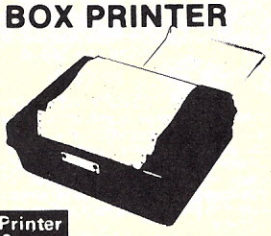
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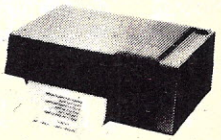
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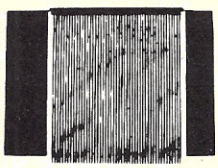
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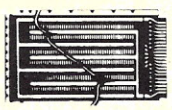
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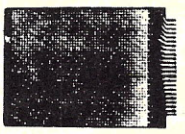
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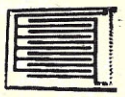
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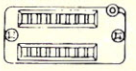
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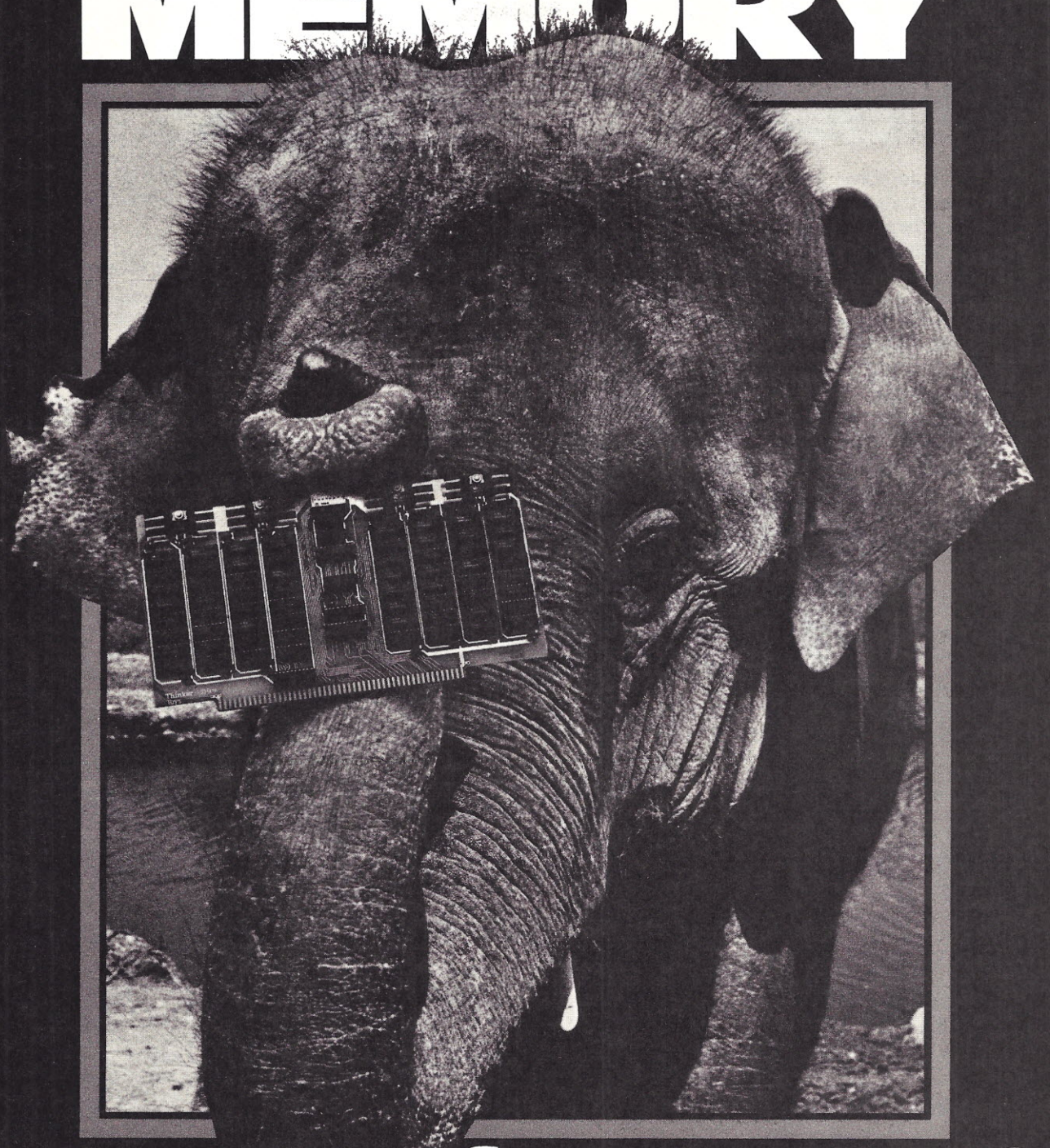
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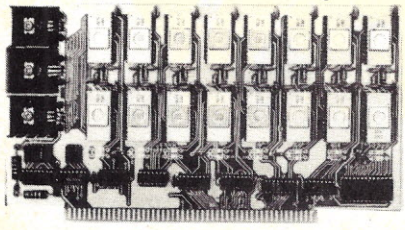
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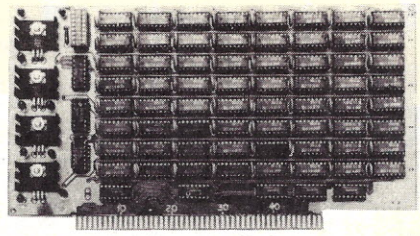
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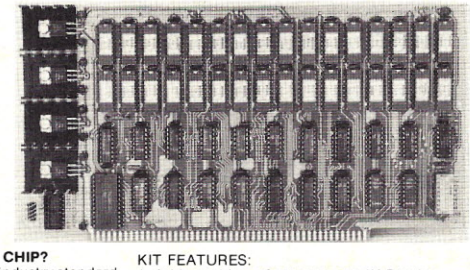
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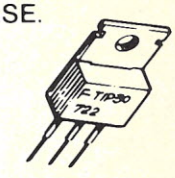
We feel the 2114 will be the next industry standard RAM chip (like the 2102 was). This means price, availability, and quality will all be good! Next, the 2114 is FULLY STATIC! We feel this is the **ONLY** way to go on the S-100 Buss! We've all heard the HORROR stories about some Dynamic Ram Boards having trouble with DMA and FLOPPY DISC DRIVES. Who needs these kinds of problems? And finally, even among other 4K Static RAM's the 2114 stands out! Not all 4K static Rams are created equal! Some of the other 4K's have **clocked** chip enable lines and various timing windows **just as critical** as Dynamic RAM's. Some of our competitor's 16K boards use these "tricky" devices. But not us! The 2114 is the ONLY logical choice for a trouble-free, straightforward design.

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6. All address and data lines fully buffered.
7. Kit includes ALL parts and sockets.
8. PHANTOM is jumpered to PIN 67.
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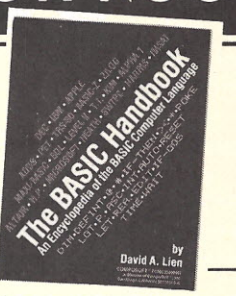
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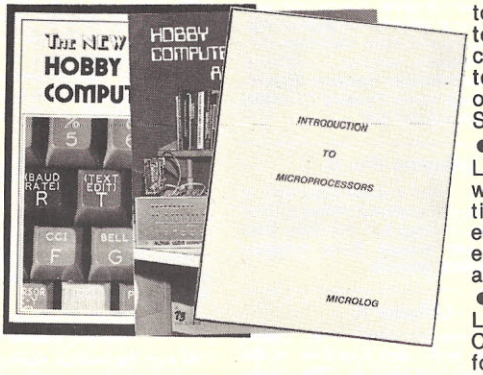


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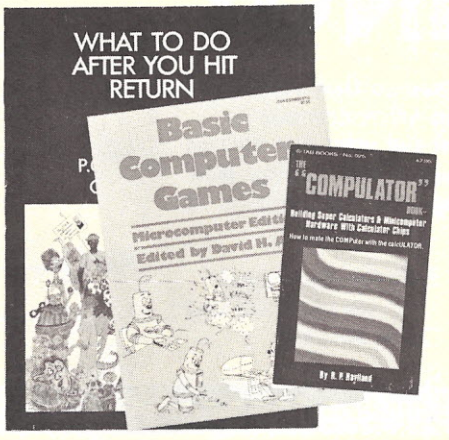


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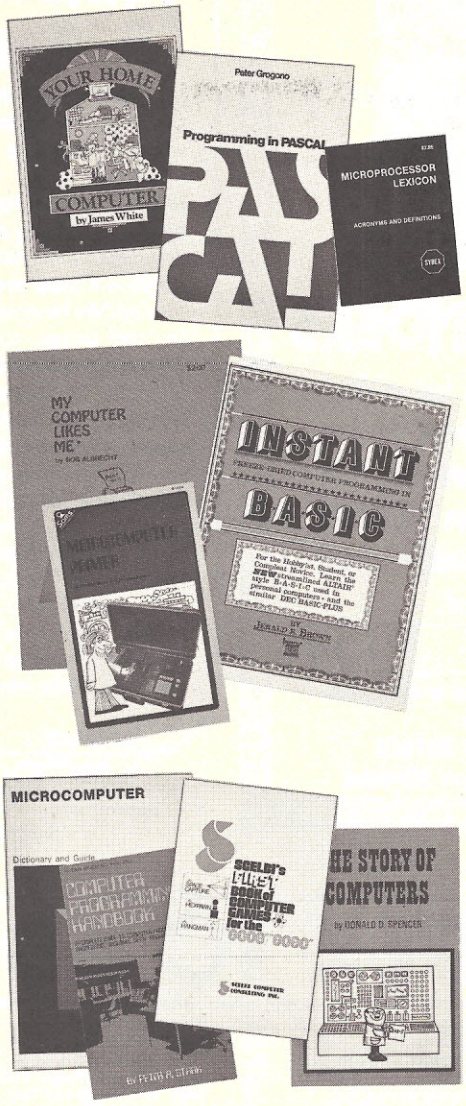
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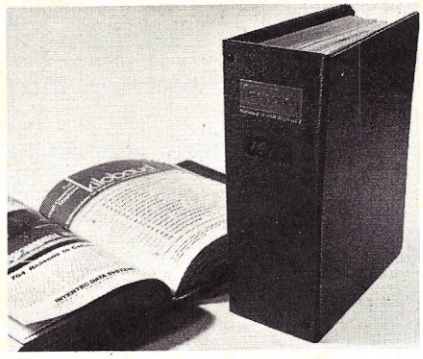
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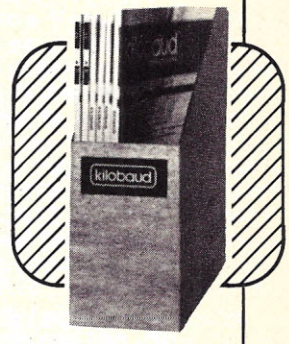
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